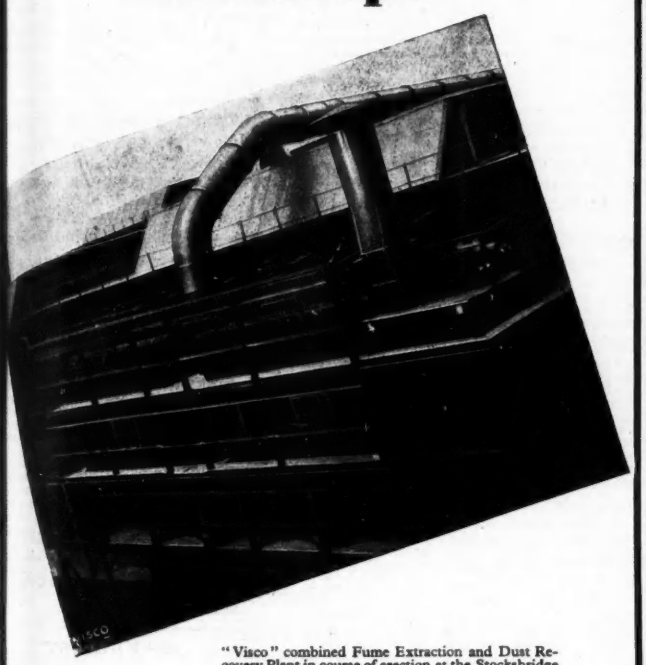
VISCO
Combined
FUME EXTRACTION & DUST RECOVERY *for* Largest Arc Furnace in Europe



"Visco" combined Fume Extraction and Dust Recovery Plant in course of erection at the Stocksbridge Works of Messrs. Samuel Fox & Co., Ltd.

he new 60-ton Birlec-Lectromelt arc furnace at the Stocks-ge Works of Messrs. Samuel Fox & Co., Ltd., is equipped a "Visco" combined Fume Extraction and Dust Recovery t for dealing with dust and fumes generated by the furnace also with the fumes given off from the moulds during the ng operation.

nstead of being exhausted to atmosphere as in most older aces, the fumes are conveyed through a long length of ing to a "Visco-Beth" Automatic Dust Collector which acts the solid particles before exhausting the clean air to sphere.

s the casting operation follows completion of melting, and ust is not required at the furnace when this is receiving a charge, the system has two branches which can be used nately and the dust collecting plant is thus available for the purpose duty.

●

onsult us on all matters relating to Fume Extraction and ust Recovery. Our 30 years' experience is at your service.

SCO ENGINEERING CO. LTD. STAFFORD RD. CROYDON

MAKERS OF WATER COOLERS, AIR FILTERS & AIR CONDITIONING PLANT

THE ENGINEER

ESTABLISHED 1856

Vol. 198 No. 5159

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NOTICE TO READERS

All letters intended for insertion in 'The Engineer' or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

SUBSCRIPTIONS

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Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

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PUBLIC APPOINTMENTS

PRESTON HARRIS INSTITUTE TECHNICAL COLLEGE

MECHANICAL AND CIVIL ENGINEERING DEPARTMENT

ASSISTANT LECTURER, GRADE B

Applications are invited for the post of ASSISTANT LECTURER, GRADE B, in the Mechanical and Civil Engineering Department.

Candidates should possess a Degree or equivalent qualification and should have had good practical experience.

Forms of application may be obtained from the undersigned, and should be completed and returned to the Technical College, Corporation Street, Preston, within two weeks of the appearance of this advertisement.

T. M. NAYLOR,
Principal.

E6798

MINISTRY OF EDUCATION

H.M. INSPECTORS (MEN AND WOMEN)

Ministry of Education requires, for England only, H.M. INSPECTORS (Men and Women), preferably under 50. Appropriate professional qualifications and teaching and practical experience desirable in architecture, clothing trades, food technology and catering, engineering (chemical, mechanical or production), management studies, metallurgy, or mining.

Posts permanent and pensionable. Inclusive salary: London, £1185 by 12 increments to £1725 (men), £1080 by 11 increments to £1550 (women); elsewhere, slightly less. A few posts carry £100 allowance. Appointments may exceptionally be made above the minimum. Higher posts filled by promotion.

Application form from the Secretary (Inspectors' Section), Ministry of Education, Curzon Street, London, W.1. Closing date 28th February. E7001

CITY OF LEICESTER

WATER DEPARTMENT

ASSISTANT CIVIL ENGINEER

ASSISTANT CIVIL ENGINEER required by Water Department of the City of Leicester, to assist in designing and constructing works for water supply, including aqueducts, service reservoirs, and the development of a new source of supply. The appointment is a permanent one and the salary is within the range A.P.T. I–V (£490–£670 per annum), depending upon qualifications and length of experience.

Applicants should have passed Sections A and B of the Institution of Civil Engineers' Examination or should hold an exempting degree. Practical experience, particularly in water supply, is desirable, but not essential.

The appointment is subject to the provisions of the Local Government Superannuation Acts, 1937 to 1953, and to a satisfactory medical examination.

Applications, giving full details of training and experience, should be submitted to the undersigned before 6th January, 1955.

HAL WALLHOUSE, A.M.I.C.E., M.I.W.E.,
Engineer and Manager.
City of Leicester Water Department,
Bowling Green Street, Leicester. E6993

BLACK SLUICE INTERNAL DRAINAGE BOARD

APPOINTMENT OF ASSISTANT ENGINEER

Applications are invited for the position of ASSISTANT ENGINEER, to be engaged on the survey, design and carrying out of land drainage works. Salary £525 to £570 per annum, plus car allowance on N.J.C. scale. The post is superannuated, but is not permanent. At least two years' work is guaranteed.

Students or graduates of professional institutions are preferred, previous land drainage experience would be an advantage.

Applications, accompanied by the names of two referees, to the undersigned to be received not later than the week commencing Monday, 20th December, 1954.

L. I. CLARK, A.M.I.C.E., &c.,
Chief Engineer.
Black Sluice Internal Drainage Board,
72, Carlton Road,
Boston,
Lincs. E696

CIVIL SERVICE COMMISSION

CIVIL ENGINEERS IN GOVERNMENT DEPARTMENTS

The Civil Service Commissioners invite applications for pensionable posts.

Age at least 25 and under 35 on 1st January, 1954, with extension for regular service in H.M. Forces and up to two years for permanent civil service. Candidates must be Corporate Members of the Institution of Civil Engineers or have passed or been exempted from Sections I and II. Wide professional experience expected.

London salary scale (men) £650 (at age 25) to £1000. Starting salary according to age up to £900 at 34. Prospects of promotion. Salaries of next higher grades are £1000–£1320 and £1375–£1575. Somewhat lower for women and in the provinces.

Further particulars and application forms from Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting No. S64/54. Completed applications must be returned by 31st December, 1954. E6926

NATIONAL COAL BOARD

CENTRAL ENGINEERING ESTABLISHMENT

APPOINTMENTS

National Coal Board invite applications for the following superannuable appointments at their Central Engineering Establishment, now under construction at Stanhope Bretby, near Burton-on-Trent, which will be engaged in the development and proving of equipment for the coal mining industry.

ENGINEER (MECHANICAL).—Salary not less than £1030 per annum. Applicants should be Corporate Members of the Institution of Mechanical Engineers or possess equivalent qualifications. The duties will comprise in the main the development of coalface machinery. Experience of the coal industry and of the development of mining equipment are essential. (Reference No. TT/882.)

ASSISTANT ENGINEER (ELECTRICAL).—Salary not less than £650 per annum. Applicants must have as a minimum qualification a Higher National Certificate in Electrical Engineering, have served a recognised apprenticeship in electrical engineering and be trained in laboratory practice relating to light electrical engineering, with particular reference to measurement employing electronic techniques. (Reference No. TT/883.)

ASSISTANT ENGINEER (MECHANICAL).—Salary not less than £650 per annum. Applicants must have as a minimum qualification a Higher National Certificate in Mechanical Engineering and have served a recognised apprenticeship in mechanical engineering. The successful applicant will be required to assist in the development and operation of heavy mechanical test rigs. (Reference No. TT/884.)

ASSISTANT ENGINEER (MECHANICAL).—Salary not less than £650 per annum. Applicants must have as a minimum qualification a Higher National Certificate in Mechanical Engineering and have served a recognised apprenticeship in mechanical engineering. The successful applicant will be required initially to give general assistance to the works manager in the installation and operation of a general engineering workshop and the installation and maintenance of heavy mechanical test rigs. (Reference No. TT/885.)

Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, marking envelope with the relevant T.T. Reference Number quoted above. Original testimonials should not be forwarded. Closing date 29th December, 1954. E6878

MINISTRY OF SUPPLY

ARMAMENT RESEARCH AND DEVELOPMENT ESTABLISHMENT

MECHANICAL ENGINEERS

MECHANICAL ENGINEERS required by Ministry of Supply at Armament Research and Development Establishment near Sevenoaks, Kent; Fighting Vehicles Research and Development Establishment near Chertsey, Surrey; National Gas Turbine Establishment near Farnborough, Hants; Aeroplane and Armament Establishment, Amesbury, Wilts; Royal Aircraft Establishment, Farnborough, Hants, and outstations. Work concerned with research, design and development of a wide range of civil and military equipment, including aircraft, armaments, fighting vehicles, gas turbines, guided weapons, rockets and accessories. Appointments according to qualifications, age and experience connected with appropriate research or development. Scientific Officers (1st or 2nd-class Hons. Graduates). Salary, £445–£815; Experimental Officers and Assistant Experimental Officers (Higher School Certificate (Science) or equivalent—Degree or H.N.C. may be an advantage). Salary E.O. (Min. age 26), £690–£850; A.E.O. £276 (age 18) to £615. Women somewhat less. F.S.S.U. benefits may be available for S.O. class. Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting C805/54A. E6964

BRITISH ELECTRICITY AUTHORITY

EASTERN DIVISION

SENIOR DRAUGHTSMEN (MECHANICAL)

Applications are invited for the following appointments in the Generation (Construction) Department at Divisional Headquarters:—

SENIOR DRAUGHTSMEN (Mechanical). Salary Schedule "D," Grade 4, £787 by £20 to £892 per annum.

The commencing salary will depend upon experience and qualifications. Applicants should preferably have experience in generating station plant layout and design of pipework, coal, ash and dust-handling systems, &c.

Applications, stating age, qualifications and experience, should be sent to the Controller, British Electricity Authority, Eastern Division, Northmet House, Southgate, N.14, by 23rd December, 1954.

W. N. C. CLINCH,
Controller.

E6941

LONDON TRANSPORT

TEMPORARY ENGINEERING ASSISTANT

London Transport require TEMPORARY ENGINEERING ASSISTANT for design of new and repair work to bridges and structures in steel and concrete with some site supervision. Qualifications: good technical education and some experience in design office or on sites. Salary range £635 to £719 10s., prospects of advancement to £783 10s.; medical examination. — Applications to Staff Officer (F/EV 516), London Transport, 55, Broadway, S.W.1. For acknowledgment enclose addressed envelope. E6969

HER MAJESTY'S OVERSEA CIVIL SERVICE

WORKS AND HYDRAULICS DEPARTMENT, TRINIDAD

CHIEF MECHANICAL ENGINEER

Applications are invited for the following post:—CHIEF MECHANICAL ENGINEER, Works and Hydraulics Department, Trinidad.

Duties of the post comprise responsibility for maintenance of fixed and construction plant and supervision of the departmental workshops.

Appointment is on contract for three years in first instance in the scale £1100 by £50 to £1200 per annum plus gratuity of £37 10s. for each completed three months' service on satisfactory termination of agreement. A small cost-of-living allowance is also payable. Recommendations for revised salaries in Trinidad are under consideration. If approved, the salary scale would be £1400–£1500, but no cost-of-living allowance would be payable.

Free passages for the officer, wife and up to three children under the age of 18. Quarters are not provided, but allowance paid towards rent for private residence. Leave at the rate of 45 days a year.

Candidates must be Corporate Members or Graduates of the Institution of Mechanical Engineers or in possession of an Engineering Degree or Diploma recognised as granting exemption from Sections A and B of the A.M.I.Mech.E. examination. They should have had good experience of operation, repair and overhaul of construction plant, such as graders, scrapers, shovels and draglines.

Apply in writing to the Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, giving briefly age, qualifications and experience. Mention the reference number BCD.112/38/04/D4. E6917

CIVIL SERVICE COMMISSION

PROFESSIONAL ENGINEERS IN VARIOUS GOVERNMENT DEPARTMENTS

The Civil Service Commissioners invite applications for pensionable posts in a wide variety of mechanical and electrical engineering duties.

Candidates must be under 35 on 1st January, 1954, with extension for regular service in H.M. Forces and up to two years for permanent civil service. For the Post Office they must be at least 21, for the Ministry of Supply and Ministry of Transport and Civil Aviation at least 23, and for all other Departments at least 25 on that date.

Generally a candidate must possess a University Degree in Engineering or be a Corporate Member of one of the professional institutions—Mechanical Engineers, Electrical Engineers or Civil Engineers—or have passes in, or exemption from, Sections A or I and B or II of the corresponding associate membership examinations. Exceptionally candidates of high professional attainment, but without the specified qualifications, may be admitted. For some posts Associate Fellowship of the Royal Aeronautical Society or an Honours Degree in Physics or Engineering will be accepted.

London salary scale (men) £650 (at age 25) to £1000. Starting salary according to age up to £900 at 34. Candidates entering below age 25 will start at salaries varying from £450 at age 21 to £570 at age 24. Prospects of promotion. Salaries of next higher grades are £1000–£1320 and £1375–£1575. Somewhat lower for women and in the provinces.

Further particulars and application forms from Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting No. S85/54. Completed applications must be returned by 31st December, 1954. E6924

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY

RISLEY

ELECTRICAL ENGINEERS, GRADES II AND III

ELECTRICAL ENGINEERS, GRADES II and III, required by United Kingdom Atomic Energy Authority at Risley, near Warrington, Grade II, to take charge of, and Grade III to work on, sections responsible for design and specification of electrical equipment for large factories, including H.T and L.T. switchgear, substations, installations and distributions. Qualifications: recognised electrical engineering apprenticeship, with Corporate Membership of Institution of Electrical Engineers, or equivalent, together with experience of the duties defined. Rate of pay: £960–£1240 for Grade II, and £620 (at age 25)–£960 for Grade III. The successful candidates will later be required to join the Authority's contributory pensions scheme, and salaries will be increased to cover the contributions.—Applications, quoting Grade applied for, to United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington. E6956

THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION

FUEL TECHNOLOGY SECTION

RESEARCH ASSISTANTS

RESEARCH ASSISTANTS are required by the Fuel Technology Section of the Physics Department of the above Association. The work will be of a varied and interesting nature, and initially will be mainly in connection with the design, instrumentation and utilisation of furnaces, together with operational studies involving the heating and cooling of steel. The post will be centred at London, but will entail visits to steel works. Applicants should have a Higher or Ordinary National Certificate in Science, Technology or Engineering, Inter. B.Sc., or equivalent qualification.—Written applications, giving full particulars of age, qualifications, past experience, and salary required, and quoting "Fuel Technology," to Personnel Officer, B.I.S.R.A., 11, Park Lane, London, W.1. E6895

CIVIL SERVICE COMMISSION

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

PRINCIPAL SCIENTIFIC OFFICER

The Civil Service Commissioners invite applications for a pensionable post at the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow.

The officer appointed will be required to initiate research into fundamental factors underlying wear and lubrication of internal combustion engines using modern techniques (e.g. radioactive tracers). He would be expected later to extend his interest to wear phenomena in machinery generally.

Age at least 32 on 31st December, 1954. Candidates must have a First or Second Class Honours Degree in Engineering or equivalent qualification. Exceptionally a candidate without this qualification may be admitted. Works training and a knowledge of internal combustion engines an advantage.

Inclusive annual remuneration (for 45½-hour week) £1122–£1516 (men), £1007–£1354 (women). Exceptionally starting salary above the minimum may be granted according to qualifications and experience.

East Kilbride is a new town with good housing prospects.

Further particulars and application forms from Civil Service Commission, Scientific Branch, 30, Burlington Street, London, W.1, quoting S4405/54. Applications must be returned by December, 1954. E6

STAFFORDSHIRE POTTERIES WATER BOARD

APPOINTMENT OF CIVIL ENGINEER ASSISTANT

Applications are invited for the following appointment:—

CIVIL ENGINEERING ASSISTANT at a salary in accordance with the new Grade A.P.T. II (£490–£640 p.a.).

Applicants must:—

(a) Have passed Part I of the Institution of Civil Engineers Examination and have at least two years' engineering experience; or

(b) Hold a University Degree in Civil Engineering and have at least one year's engineering experience.

The appointment is subject to the provisions of the National Scheme of Conditions of Service; the provisions of the Local Government Superannuation Act, 1937; to termination by one month's notice on either side; and to the successful candidate passing a medical examination.

Applications, stating age, full details of training, qualifications, present and previous appointments, details of experience, together with copies of not more than two recent testimonials, or the names of two persons to whom reference can be made, should be forwarded to the undersigned not later than Tuesday, 14th December, 1954.

C. V. BROWN, M.I.C.E., M.I.Mech.E., M.I.Mun.E.,
Engineer and Manager and Clerk to the Board,
Staffordshire Potteries Water Board,
Albion Street, Hanley,
Stoke-on-Trent. E6

AIR MINISTRY

LONDON

DESIGNER-DRAUGHTSMEN

Air Ministry require in London DESIGNER-DRAUGHTSMEN for bulk petroleum storage and pumping installations, experienced in one or more of the following: (a) storage tank layout and design, (b) pump house and plant layout, (c) development and pipeline schemes, (d) hydraulic calculations. Technical training to O.N.C. standard required. Salary up to £670 p.a., starting pay based on age, qualifications and experience. Overtime payable. Pension, prospects and long-term possibilities. Naturalised British subjects only.—Write, stating age, qualifications, employment details, including type of work done, to Ministry of Labour, 236, Walworth Road, London, S.E.17, quoting Order 3593. E

LONDON TRANSPORT

DRAUGHTSMEN

London Transport require DRAUGHTSMEN for permanent way development section, with mechanical engineering training and some electrical knowledge, capable of preparing working drawings from rough sketches and experimental assignments for improvements to civil engineering plant and mechanical handling equipment. Salary scale £343 10s. at age 21, rising to £613 10s., subject to age and satisfactory service, with additional payment for certain recognised qualifications. Written examination; contributory superannuation scheme; after probation; certain free travel.—Application to Staff Officer (F/EV 518), London Transport, 55, Broadway, S.W.1. For acknowledgment enclose addressed envelope.

COUNTY BOROUGH OF EAST HAM

ENGINEERING ASSISTANT, GRADE A.P.T. II
£620–£670

London weighting is paid in addition. Salary in excess of the minimum may be paid according to qualifications and experience.

A subsistence allowance may be granted at a reasonable period to the person appointed if he has to obtain suitable housing accommodation, necessitating the maintenance of two homes.

Further details and application forms, returned by 24th December, 1954, from the Town Clerk, Town Hall, East Ham, E.6. E

THE ENGINEER

DECEMBER 10, 1954

Air Pollution Conference

ON Wednesday and Thursday of this week there was held at Harrogate a conference, organised by the Combustion Engineering Association on "Industrial Aspects of Air Pollution." The conference was opened by the Mayor of Harrogate. Then, after the chairman, Mr. B. E. A. Vigers, president of the Association, had made a few remarks, Sir Hugh Beaver addressed the meeting. He did not attempt to review the findings of the Beaver Committee. But he stressed the change in the nation's attitude from that which used to exist in which air pollution was regarded as a necessary evil to the attitude of to-day when the necessity was being questioned. He remarked also that the direct benefit to any industry or individual of abolishing air pollution was open to question. It might cost them money. But the indirect benefit of clean air would be felt by the nation as a whole. It was for that reason that the committee felt there to be "a legitimate claim that part of the cost of what is unquestionably a national benefit should be nationally borne." This opening session of the conference dealt with "Industry and Air Pollution." The afternoon's session and the session on Thursday morning had as their subject "The Problems of Industry"; and, at the final session on Thursday afternoon, "The Problem of Small Industry Using Steam" was discussed.

British Transport Commission Technical Committee Appointment

IT is announced by the British Transport Commission that Mr. F. Q. den Hollander, president of the Netherlands Railways, has accepted an invitation to become a member of the Commission's technical development and research committee. Mr. den Hollander, who is also president of the Office for Research and Experiments of the International Union of Railways, is very well known in the transport world and his assistance on the committee will help it to keep closely in touch with Continental practice. Mr. den Hollander was educated at Goes Grammar School, Zeeland, and at Delft Technical University. In 1918 he joined the Netherlands Indies State Railways and occupied various posts during the following twenty years. On his return to Europe in 1938 he was appointed assistant manager to the Government Workshops, and in 1940 he became general manager. After the liberation of Holland in May, 1945, he became permanent under-secretary to the Minister of Economic Affairs, and was appointed general managing director of transport with the Ministry of Transport in October, 1945. He became general manager of the Netherlands Railways in 1946, and president in 1947. Mr. den Hollander is an honorary member of several British technical and professional institutions.

Chemical Vapours as Fire Extinguishing Agents

THE report of the committee set up by the Fire Research Board in 1952 to consider the problems involved in the use of vaporising liquid extinguishing agents has been published this week. It reviews the characteristics desirable in vaporising liquids for use in putting out fires and to advise on tests to assess the suitability of promising alternatives to compounds at present in use. The agents were assessed by their efficiency as fire fighters, their toxicity, and the toxicity of their decomposition products, their physical properties, their effect on materials with which they come in contact, and their cost. No compound was found which combines high efficiency as an extinguishing agent with complete absence of toxic hazard, but the report says that considerable improvement in the efficiency of fire-fighting can be effected by the use of the newer agents, especially for special risks. Thus, chlorobromomethane was found to be much superior to carbon tetrachloride, having a higher extinguishing efficiency and a lower toxic hazard. The compound has the advantage that it can be used, with only minor modifications, in appliances already using carbon tetrachloride. In many cases it can be substituted with advantage for methyl bromide. Among the newer extinguishing agents the fluorobromo hydrocarbons show advantages which could justify their use despite their higher cost and the committee recommends that their development should be continued. The report notes that little information was available on the health and life hazards associated with the acid gases generated, and it refers to work carried out on small animals. Very dangerous concentrations, the report discloses, would exist in the cabin of aircraft if those fluids were used.

Cathodic Protection of Buried Structures

WE are informed by the British Electricity Authority that it has now formed a joint committee for the co-ordination of the application of cathodic protection to buried structures. It points out that evidence of the increasing use of the method in this country is provided by the fact that, although the records are not yet complete, information has already been received on some 200 installations which are either in operation or projected. Installations by impressed current or reactive anodes are in use on water, gas, oil and sewage pipes, telephone and electricity supply cables and structures such as oil tanks and jetties. The need for co-ordination arises largely from the fact that current circulating in the soil due to a cathodic protection installation may accelerate the corrosion of nearby structures. Methods of assessing the probability of damage in particular cases are being studied. One method of preventing such harmful interaction is to extend the cathodic protection to neighbouring structures by connecting them to the protected structure, with suitable safeguards where necessary, either directly or through resistors or other devices. It is, therefore, necessary to consider the conditions under which such interconnection of buried structures is permissible. Membership of the committee has been confined to representatives of organisations or industries responsible for buried structures through ownership or otherwise. At present the organisations represented include the British Electricity Authority, the British Transport Commission, the Gas Council, the General Post Office, United Kingdom Pipelines, and the Water Research Association. Since it will ultimately be necessary to make the findings of the committee generally available in the form of a Code of Practice, a technical panel has been set up, under the chairmanship of Dr. F. Wormwell, to study cathodic protection with a view to the eventual drafting of a code. Arrangements have been made to ensure liaison with the British Cast Iron Research Association, the British Electrical and Allied Industries Research Association, the British Iron and Steel Research Association and the British Non-Ferrous Metals Research Association.

Reorganisation of Research in France

ON the accession of Monsieur Mendes-France, the formation was announced in France of a Ministry for Scientific Research and Technical Progress, with the task of controlling all government as well as private research and directing developments. Monsieur Henri Longchambon, the new Secretary of State, is to form an advisory council which will consist of eight sections as follows :—Documentation and information ; definition of objectives, recruitment and subsidies ; mobilisation in case of war ; relations between research organisations, including exchanges of personnel ; training of research workers ; foreign relations ; industrial property, market studies and patents, and public relations. Organisations which now pass from the control of various ministries to that of the Secretary of State include the National Office of Aeronautical Studies and Research, the National Centre of Scientific Research, the Scientific and Technical Institute for Marine Fisheries, the Bureau of Geological and Geophysical Research, the National Institute of Agronomic Research, the Office of Overseas Scientific Research, the Scientific and Technical Centre for the Building Industry, the National Institute of Hygiene, and the National Institute of Demographic Studies. In addition, the Secretary of State will continue to supervise the special committee on the Zones of Industrial Organisation of the French Union, the Bureau for the Organisation of African Industry, and the Atomic Energy Commission. In the 1955 Budget provision is made for the creation or development of research institutes at Lyons (inorganic chemistry), Montpellier (structural organic chemistry), Nacy (chemical kinetics and physical chemistry), Gif-sur-Yvette (plant physiology), Marseilles (biochemistry), and Grenoble (physics of metals, and electrostatics). The main stress, however, is on the expansion of nuclear studies. A new institute at the Sorbonne is to house a 100MeV synchrocyclotron, a 2MeV particle accelerator, and an isotope separator. The centres at Strasbourg and Lyons are to be expanded and re-equipped, the former with a 6MeV accelerator, and an accelerator of French design is to be installed at a new centre at Grenoble.

Oil Fuel at Home

ON Tuesday of this week an exhibition, "Oil Fuel at Home," was opened by the Parliamentary Secretary, Ministry of Fuel and Power, Mr. L. W. Joynson-Hicks, at the Building Centre, Store Street, London, W.C.1. The exhibition, which will remain open until December 31st, is sponsored by Shell-Mex and B.P., Ltd., and the Parliamentary Secretary was welcomed by Mr. C. M. Vignoles, the managing director of the company. In his remarks Mr. Vignoles stressed the need to use fuel economically and efficiently and said that this applied particularly to oil which had to be imported. It was essential, he continued, to use the right fuel and get the best out of equipment and this applied not only to industry but to domestic appliances which was the category of oil burning equipment displayed at the exhibition. Coal, Mr. Vignoles commented, was a wasteful means of space heating and he went on to say that oil burners could also be wasteful if the air supply was not correctly adjusted. Before declaring the exhibition open, Mr. Joynson-Hicks said that the continuous expansion in industrial production since the war had increased the demand for power, and that the production of coal at home had not been able to satisfy this demand. Under these circumstances he welcomed the exhibition, which demonstrated to householders how they could, by installing oil-burning equipment, provide a clean and efficient system of heating and at the same time reduce the demand for coal. Mr. Joynson-Hicks called attention to the fact that oil correctly burned produced no smoke so that its use made a helpful contribution to the reduction of air pollution. The exhibition, in which about thirty firms have co-operated, displays a number of oil burners ranging from small vaporising units, suitable for a household boiler, to the larger pressure jet or air-atomising burners. Various fuel saving devices and automatic controllers are also on view, together with a working boiler exhibit.

Stresses in Rectangular Plate Projections

By J. C. CHAPMAN, Ph.D., A.M.I.C.E.

No. II—(*Concluded from page 765, December 3rd*)

The relaxation method is used to derive displacements and stresses in rectangular plates having imposed displacements or forces along one long edge. The plates may be taken to represent in a very idealised form the sides of a ship's superstructure, or any other rectangular structural element which is loaded in a similar way. The equations and methods of solution given are applicable to either stiffened or unstiffened plates, but solutions are given for unstiffened plates only. Stresses derived from displacement solutions are given for plates having side ratios of 2 : 1, 4 : 1, 6 : 1 *and infinity. They are in a form suitable for synthesising stresses for any imposed circular curvature, together with any imposed uniform strain. Two solutions are also given for* 6 : 1 *plates having an attachment along the unloaded edge. Two solutions for a different edge loading are derived in terms of a stress function. Some experimental confirmation is given for certain conditions.*

SOME of the observations which can be made from a study of the numerical and experimental results which were given in Part I are discussed hereunder :—

(1) For uniform strain and zero curvature imposed on a very long plate the strain at the outer edge reaches 95 per cent of the imposed strain at a distance from the end equal to three and a half times the depth.

(2) For uniform curvature and zero strain imposed on a very long plate the strain at the outer edge reaches 95 per cent of the simple bending strain at a distance from the end equal to three times the depth.

(3) For uniform strain and zero curvature the strain at the centre of the outer edge reaches 95 per cent of the imposed strain where the side ratio is 9 : 1.

(4) For uniform strain and zero curvature imposed on a simple 6 : 1 plate the strain at the outer edge has a maximum value of 82 per cent of the imposed strain. When a flange having a cross-sectional area about equal to that of the plate is attached to the outer edge, this strain is reduced to 49 per cent of the imposed strain.

(5) For a 2 : 1 plate having uniform imposed strain accompanied by zero normal force (i.e. its curvature is not imposed) the stress difference at the centre between the top and bottom edges of the plate is about 95 per cent of that predicted by the simple bending theory. For a 4 : 1 plate this difference is almost 100 per cent of the simple bending value.

Notation.

σ_x, σ_y—Normal components of stress parallel to x, y axes.
τ_{xy}—Shearing stress.
u, v—Components of displacement, in x and y directions.
σ_{xs}—Direct stress in longitudinal stiffening member.
σ_{ys}—Direct stress in transverse stiffening member.
$\bar{\sigma}_x, \bar{\sigma}_y, \bar{\tau}_{xy}$—"Mean applied stresses," defined so that $t\bar{\sigma}_x$, $t\bar{\sigma}_y$ and $t\bar{\tau}_{xy}$ are forces per unit length in the plate-stiffener combination.
t—Plate thickness.
α_x, α_y—Areas of longitudinal and transverse stiffeners, expressed as a fraction of the plate area.
$r_x = \frac{1}{1+\alpha_x(1-\nu^2)}$.
$r_y = \frac{1}{1+\alpha_y(1-\nu^2)}$.
ν—Poisson's ratio (taken as 0·3 for computations).
$\beta_x = 1+\alpha_x(1-\nu^2)$.
$\beta_{xy} = 1+(1+\nu)[\alpha_x+\alpha_y+\alpha_x\alpha_y(1-\nu^2)]$.
$\beta_y = 1+\alpha_y(1-\nu^2)$.
a—Relaxation net size.
ϕ—Airy stress function.
T_x—Force in flange.
A—Cross-sectional area of flange.
e_x, e_y—Normal components of strain parallel to x, y axes.
γ_{xy}—Shearing strain.
E—Modulus of elasticity.
H—Smaller dimension of projection.

Details of Solutions

Displacement Solutions.—When edge displacements are specified, solutions can be derived in terms of u and v, and the stresses can then be easily found.

Basic Equations.—The stress components in the plate, σ_x, σ_y and τ_{xy} are given in terms of displacements by the equations:

$$\sigma_x = \frac{E}{1-\nu^2}\left(\frac{\partial u}{\partial x}+\nu\frac{\partial v}{\partial y}\right)$$
$$\sigma_y = \frac{E}{1-\nu^2}\left(\frac{\partial v}{\partial y}+\nu\frac{\partial u}{\partial x}\right)$$
$$\tau_{xy} = \frac{E}{2(1+\nu)}\left(\frac{\partial u}{\partial y}+\frac{\partial v}{\partial x}\right) \quad . \quad . \quad . \quad (1)$$

whilst for the longitudinal and transverse stiffening members respectively the direct stresses are given by:

$$\sigma_{xs} = E\frac{\partial u}{\partial x}$$
$$\sigma_{ys} = E\frac{\partial v}{\partial y} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

It is assumed that the stiffeners are sufficiently closely spaced for the combination to be treated as an orthotropic plate. $\bar{\sigma}_x$, $\bar{\sigma}_y$, and $\bar{\tau}_{xy}$, the "mean applied stresses,"* are then defined so that $t\bar{\sigma}_x$, $t\bar{\sigma}_y$, and $t\bar{\tau}_{xy}$ are the forces per unit length in the plate stiffener combination, where t is the thickness of the plate.

The equilibrium equations can then be written:

$$\frac{\partial\bar{\sigma}_x}{\partial x}+\frac{\partial\bar{\tau}_{xy}}{\partial y}=0$$
$$\frac{\partial\bar{\sigma}_y}{\partial y}+\frac{\partial\bar{\tau}_{xy}}{\partial x}=0 \quad . \quad . \quad . \quad . \quad (3)$$

From the definition of $\bar{\sigma}_x$, &c., and because the stiffeners do not contribute to the shearing resistance of the combination,

$$\bar{\sigma}_x = \sigma_x+\alpha_x\sigma_{xs}$$
$$\bar{\sigma}_y = \sigma_y+\alpha_y\sigma_{ys}$$
$$\bar{\tau}_{xy} = \tau_{xy} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where α_x and α_y are the stiffener cross-sectional areas relative to the plate area.

Substituting for $\bar{\sigma}_x$, &c., from (4) in (3), the equilibrium equations become:

$$\frac{\partial\sigma_x}{\partial x}+\alpha_x\frac{\partial\sigma_{xs}}{\partial x}+\frac{\partial\tau_{xy}}{\partial y}=0$$
$$\frac{\partial\sigma_y}{\partial y}+\alpha_y\frac{\partial\sigma_{ys}}{\partial y}+\frac{\partial\tau_{xy}}{\partial x}=0 \quad . \quad . \quad . \quad (5)$$

By substituting the expressions 1 and 2 for the stresses, the following equations for u and v can be derived:

$$2[1+\alpha_x(1-\nu^2)]\frac{\partial^2 u}{\partial x^2}+(1-\nu)\frac{\partial^2 u}{\partial y^2}+(1+\nu)\frac{\partial^2 v}{\partial x\partial y}=0$$
$$2[1+\alpha_y(1-\nu^2)]\frac{\partial^2 v}{\partial y^2}+(1-\nu)\frac{\partial^2 v}{\partial x^2}+(1+\nu)\frac{\partial^2 u}{\partial x\partial y}=0$$
$$. \quad . \quad . \quad . \quad . \quad (6)$$

* E. H. Mansfield, "Neutral Holes in Plane Sheet," R.A.E. Report Structures 90.

These equations, together with the known boundary displacements and stresses, enable u and v (and consequently the stresses) to be found at all points of the relaxation net.

Finite Difference Approximations.—The following approximate relations for differential operators at point 0 are used :

$$2a\frac{\partial u}{\partial x} = u_1-u_3$$
$$2a\frac{\partial u}{\partial y} = u_2-u_4$$
$$a^2\frac{\partial^2 u}{\partial x^2} = u_1+u_3-2u_0$$
$$a^2\frac{\partial^2 u}{\partial y^2} = u_2+u_4-2u_0$$
$$4a^2\frac{\partial^2 u}{\partial x\partial y} = u_5-u_6+u_7-u_8$$

where the suffixes define points distant "a" apart on a square net, as follows :

```
          10
        6   2   5
    11  3   0   1   9
        7   4   8
          12
```

Equations (6) can then be written in terms of finite differences:

$$2[1+\alpha_x(1-\nu^2)](u_1+u_3-2u_0)+(1-\nu)(u_2+u_4-2u_0)+\left(\frac{1+\nu}{4}\right)(v_5-v_6+v_7-v_8)=0$$
$$2[1+\alpha_y(1-\nu^2)](v_2+v_4-2v_0)+(1-\nu)(v_1+v_3-2v_0)+\left(\frac{1+\nu}{4}\right)(u_5-u_6+u_7-u_8)=0$$
$$. \quad . \quad . \quad . \quad . \quad (7)$$

These equations can be solved for all points of the chosen net by a process of "iterative relaxation," provided that fictitious external values of u and v are found from the boundary conditions for each successive distribution.

Free Boundary Conditions.—In order to calculate residuals at a boundary where u or v is unknown it is necessary to find fictitious external values of u and v. These values can be found from equations (1), (2) and (4) for at the top edge $\bar{\sigma}_y=\bar{\tau}_{xy}=0$ and at the ends $\bar{\sigma}_x=\bar{\tau}_{xy}=0$.

At the top edge:

$$v'_2 = v_4-vr_y(u_1-u_3)$$
$$u'_2 = u_4-(v_1-v_3).$$

At the end:

$$u'_3 = u_1-vr_x(v_2-v_4)$$
$$v'_3 = v_1+(u_2-u_4) \quad . \quad . \quad . \quad (8)$$

where

$$r_x = \frac{1}{1+\alpha_x(1-\nu^2)}$$
$$r_y = \frac{1}{1+\alpha_y(1-\nu^2)}$$

and u'_3, v'_3, &c., are fictitious external values of u and v.

At a corner:

$$(u'_2-u_4)+(v_1-v'_3)=0 \quad . \quad . \quad (9)$$

and there is only this equation to determine u'_2 and v'_3. These values are then found by graphical extrapolation of u and v, each extrapolation being equally adjusted, where necessary, in order to satisfy equation (9). The first and third of equations (8) both hold, giving

$$u'_3 = u_1$$
$$v'_2 = v_4$$

The external values u'_6 and v'_6 can only be found by diagonal extrapolation, but errors so involved do not greatly affect the residuals.

Stresses at the Lower Boundary.—In order to find stresses along the edge where displacements are specified it is necessary to find fictitious external values of u and v. This can be done by satisfying the equations (7) at each mesh point after completion of the

relaxation, since these external values are not required for the determination of displacements. The method used was to guess values of, say, v', when a first estimation of u' could be made at every point, from the first of equations (7). Then using these values in the second of equations (7) v' could be improved, and so on. The difficulty at the corner was met by the arbitrary assumption that

$$u'_4-u_0=u_0-u_2$$

and

$$v'_4-v_0=v_0-v_2.$$

The assumption used at the corner has little effect on the stresses remote from the corner.

Effect of Mesh Length.—The limiting accuracy attainable for a given mesh size can be examined by considering a section remote from the ends of a very long plate. At such a section plane sections remain plane and filaments parallel to the lower boundary remain parallel after straining. The first of equations (7) is then automatically satisfied, and it only remains to satisfy the second equation, of which the third term is zero, and the second term is a constant. The first term is then also a constant, and it can easily be verified that the finite difference relation then represents the second derivative exactly, for any value of "a." Thus at sections sufficiently remote from the ends of a very long plate the accuracy of the solution is independent of "a."

In order to examine the general accuracy of the standard mesh solutions ($a=H/4$), solutions for the 2 : 1 plate were found for a mesh length $a=H/8$. Longitudinal stresses σ_x on the vertical centre line for the two boundary conditions were found to be:

Uniform strain		Uniform curvature	
$a=H/4$	$a=H/8$	$a=H/4$	$a=H/8$
−7	−8	21	23
	1		17
10	11	12	13
	22		10
33	35	8	9
	50		7
64	65	4	4
	82		0
100	100	−5	−1

For uniform edge strain, the stresses are given as a percentage of σ_x at the centre of the lower edge of the plate. For uniform curvature, the stresses are given as a percentage of the simple bending value of σ_x at the upper edge of the plate.

These figures, and a further fine mesh exploration near the end of the 6 : 1 plate, indicate that the coarser mesh is sufficiently accurate at more than two or three mesh lengths from a corner.

The error decreases rapidly as the distance from the corner increases. For instance, in the case of the 2 : 1 plate subjected to uniform edge strain, the differences between coarse and fine mesh values of σ_x on a diagonal line from the corner, expressed as a percentage of σ_x at the centre of the lower edge of the plate are :

9, 2, 2, 1.

Effect of Flange.—It is assumed that the flange is sufficiently compact for the stress distribution over its cross section to be constant, and that its bending rigidity is sufficiently small for the vertical forces which it exerts upon the plate to be neglected. Then the axial force in the flange exists by virtue of the shear stress τ_{xy} along the junction and is

$$T_x=AE\frac{\partial u}{\partial x}$$

where A is the flange area and $\frac{\partial u}{\partial x}$ is the strain along the junction. Also

$$\frac{dT_x}{dx}=t\tau_{xy}$$

so that

$$t\tau_{xy}=AE\frac{\partial^2 u}{\partial x^2}.$$

Now

$$\tau_{xy}=\frac{E}{2(1+\nu)}\left(\frac{\partial u}{\partial y}+\frac{\partial v}{\partial x}\right)$$

so

$$\frac{\partial u}{\partial y}+\frac{\partial v}{\partial x}=\frac{2A(1+\nu)}{t}\frac{\partial^2 u}{\partial x^2} \quad . \quad . \quad . \quad (10)$$

This equation enables the displacements to be found at the junction between the plate and the flange. It can be written in finite differences:

$$(u'_2-u_4)+(v_1-v_3)=\frac{4A(1+\nu)}{at}(u_1+u_3-2u_0)$$
$$. \quad . \quad . \quad . \quad . \quad (11)$$

This equation enables u'_2 to be found, and v'_2 can be found as for the simple projection from the condition $\bar{\sigma}_y=0$. Residuals can then be calculated along the plate-flange junction.

For the particular case $\frac{A}{Ht}=0{\cdot}96$

$$a=\frac{H}{4}$$

$$\nu=0{\cdot}3$$

$$\alpha_x=\alpha_y=0$$

the u equation at the boundary becomes, on substituting for u'_2 from (11) in the first of (7),

$$16(u_1+u_3)+1{\cdot}4u_4-33{\cdot}4u_0-0{\cdot}7(v_1-v_3)$$
$$+0{\cdot}325(v_5-v_6+v_7-v_8)=0$$

and boundary residuals can be relaxed by use of the pattern

$$16\_\_\_-33{\cdot}4\_\_\_16$$
$$\quad\quad\quad

Early Marine Steam Turbine Proposal

By H. PHILIP SPRATT

More than half a century before Sir Charles Parsons achieved his spectacular success with the "Turbinia" at the Spithead Naval Review in 1897, two other British inventors, Messrs. Cordes and Locke, had obtained 32 b.h.p. from their experimental steam turbine. In 1846 the partners constructed a detailed scale model to show the marine application of their turbine in a vessel of about 700 tons, and this historical exhibit has now been presented by Mr. J. L. B. H. Cordes, F.R.S.A., to the national collections at the Science Museum in London. It represents one of the earliest practical schemes for marine steam turbine propulsion.

THAT steam produced from water, when heated, would issue with considerable force from a small aperture in the container, was known to the ancients. The principle had, in fact, been utilised in the æolipile of Heron of Alexandria[1] about A.D. 50, and Philibert de L'Orme had proposed the use of an æolipile to force smoke up a chimney.[2] Other applications of the æolipile are described by Salomon de Caus, of Normandy, who, after David Rivault,[3] seems to have been about the first, in 1615, to comprehend the enormous power of steam.[4]

More mature plans for a steam turbine came from Giovanni Branca, an architect of Loretto, who in 1629 published[5] the description of such a machine. The water was heated in a closed vessel, and the steam was directed from a tube with impulsive effect on to radial vanes formed on the rim of the wheel. This was mounted on a vertical shaft, with a toothed pinion at its lower end. The power is said to have been used to work pestles or stampers in chemical mortars. There is no record that Branca ever considered the problems of ship propulsion ; but one of his compatriots, Serafino Serrati of Florence, did contrive to move a small model boat on a pond by means of hot air reaction, about 1787 or earlier.[6]

Other steam turbines on the principles of Heron or Branca included those of Kircher[7] in 1643, Daslesme in 1699, W. von Kempelen[8] in 1785, James Sadler in 1791, and Richard Trevithick[9] for screw propulsion in 1815. These are all mentioned by an eminent naval architect,[10] who denounced the rotary machine as "false in its mathematical principles, and fallacious as a mechanical structure."

John Stevens, of Hoboken, N.Y., a famous American steamboat pioneer, had in 1802 fitted a 25ft flat-bottomed boat with a screw propeller at the stern. To avoid the "mischievous" inertia effects of an alternate to-and-fro piston mass, the screw propeller was direct coupled to a small rotary steam machine. This comprised a cylindrical chamber of brass, about 8in diameter and 4in axial length,[11] in which (mounted on the screw shaft) ran a simple form of two-bladed rotor. Colonel Stevens obtained a speed of 4 miles per hour, but was not satisfied with the experiments until he had replaced his rotary machine by an orthodox steam cylinder and piston.

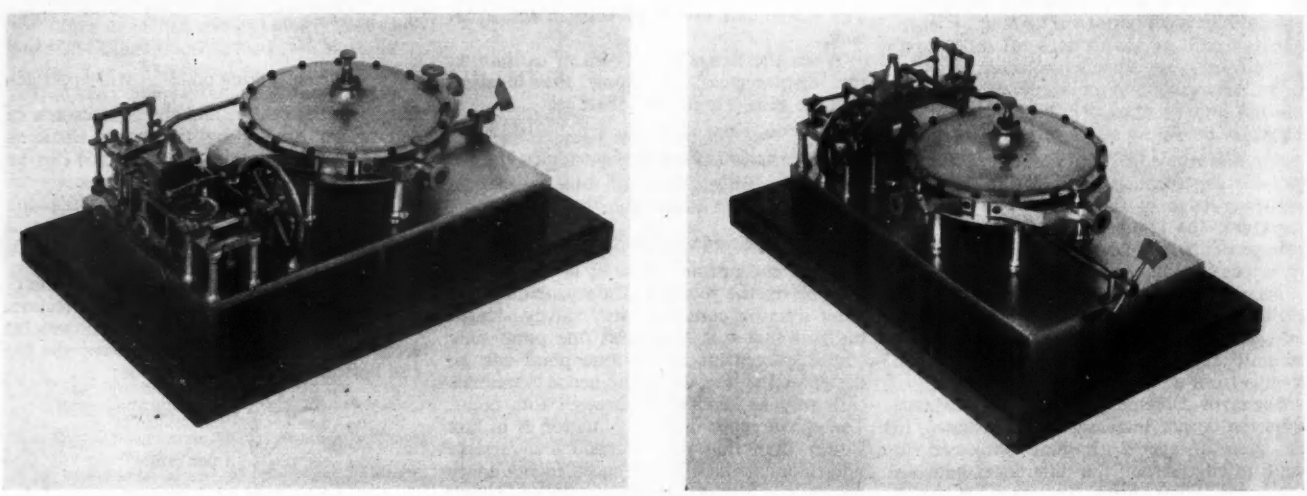
About this time Oliver Evans, of Philadelphia, another steamboat pioneer, had tried an æolipile on the same principle as Heron. The rotary tube was 3ft long, which means that each arm was 18in radius. The steam apertures were 0·2in diameter, or 0·063 square inch total area. Supplied with steam at 56 lb per square inch pressure, the machine made between 700 and 1000 r.p.m., and, in the inventor's own words,[12] it exerted "more than the power of two men."

Another steam reaction turbine on the Heron principle was developed in the United States about 1833 by the American inventor William Avery, of Syracuse, N.Y. His first experimental machine[13] had two rotary arms 18in radius ; the steam apertures at their outer ends had a total area of 0·125 square inch, and moved in a circumference of 113in. The boiler had a surface of 69 square feet exposed to the fire, which consumed half a cord of wood per day. The steam pressure was 80 lb per square inch, and the machine developed about 9 b.h.p. at 4000 r.p.m. Mr. Avery used it for eighteen months to drive his workshop.

In 1834 a British patent[14] for the Avery steam turbine was obtained by Mr. Alexander Craig, who developed it in partnership with Mr. John Ruthven, of Edinburgh. An experimental machine of 15 b.h.p. was constructed,[15] in which "the steam is conveyed by a pipe to a hollow axle ; on this axle two arms are fixed ; these are also hollow, with apertures into the axle to allow the steam to pass from the axle into the arms ; and at the end of each arm is an aperture through which the steam is discharged at right angles to the arms." In this turbine the two arms were of 30in radius,[16] and made 3000 r.p.m.; it was described as "one of the happiest applications of steam power." Subsequent improvements in the Avery reaction steam turbine were proposed about 1845 by Mr. James Black in the United States.[17]

Meanwhile the achievement of a practical steam turbine on the impulse principle of Giovanni Branca seems to have been due to British enterprise. In 1840 the partners James Jamieson Cordes and Edward Locke, both of Newport, Monmouthshire, obtained a patent[18] for a "new rotary engine." This was to consist of a revolving wheel enclosed in an exhausted chamber, and put in motion by the direct action of a current of steam entering the chamber tangential to the circumference of the wheel, and impinging against suitable vanes affixed to that circumference. The steam was exhausted from the chamber into a condensing apparatus. The power developed by the turbine was to be communicated from the axle of the wheel to any mill work or machinery which it was intended to drive. The patent contained no explicit mention of ship propulsion.

Soon afterwards a more detailed technical description was published.[19] The turbine casing was made of cast iron in two parts, fastened by nuts and bolts, and provided with stuffing-boxes for the rotor shaft. The rotor was built of wrought iron, and the vanes mounted on the rim were of copper, set at a suitable angle. The steam was admitted by a throttle valve and, after striking against the vanes, was exhausted to the condenser. The rotor shaft carried toothed gearing to drive any millwork or machinery, also a mitre wheel for the turbine governor to control the steam throttle valve and thereby the speed of the turbine. Cold water circulation was to be used for cooling the main bearings of the rotor shaft.



Model of Cordes and Locke's proposed marine steam turbine of 1846. The condenser air pumps may be observed in the forward view on the left; the right-hand illustration shows the turbine from aft, with its screw shaft and propeller

In 1846 the partners, Messrs. Cordes and Locke, constructed their small rotary machine or steam turbine at the Surrey Docks, Rotherhithe, for experimental purposes. The rotor was 11·6ft diameter, mounted on a horizontal shaft and built up with twenty-eight radial arms and vanes. The breadth of each vane was 6in and the depth 7in ; the vane area was thus 42 square inches. The steam orifice was of oval shape, 3in by 2in, and was set vertically. The report[20] of Mr. Josiah Parkes, C.E., who was appointed to test the turbine, states that it developed 32 b.h.p. at 502 r.p.m. The boiler pressure was 2·75 lb per square inch above atmospheric, and a vacuum of 27·2in was maintained inside the wheel case. The evaporation of water amounted to 100·5 lb per b.h.p. per hour.

The marine turbine proposal of 1846 is represented in detail by the contemporary model shown in the illustrations. This is beautifully constructed in brass to a scale of 1 : 64. It shows a rotor 19ft diameter, with copper rims built up on six radial arms, and mounted on a vertical shaft. Between the rims were placed eighteen radial copper vanes, each 18in wide and 18in deep ; the vane area was thus 324 square inches. This turbine had two oval-shaped steam orifices, 4·75in by 3·12in for ahead motion, and two others for astern, all set horizontally. The orifices were mounted in pairs, one ahead and one astern, for each of the two steam inlet pipes from the boiler. Reversal was effected by two semi-rotary two-way cocks, one to each steam inlet, which controlled the distribution to the respective ahead or astern orifice as required.

The turbine was intended to develop 150 b.h.p. at 300 r.p.m., with a boiler pressure of about 3 lb per square inch above atmospheric. The two vertical air pumps for the condenser were each 45in diameter by 24in stroke and were driven by side levers and one vertical steam cylinder, 33in diameter by 48in stroke. The side levers also had vertical arms and connecting-rods to drive a crankshaft with flywheel 10ft diameter, which served to carry the pumps over the dead centre. About 27·2in of vacuum was anticipated inside the turbine case.

The lower end of the main rotor shaft carried a pinion of thirty teeth, which meshed with a bevel wheel of sixty teeth mounted on the horizontal propeller shaft. This was intended to run at 150 r.p.m. and is shown fitted with a two-bladed screw propeller, of 10ft diameter, for a small wooden hulled coastal vessel of about 700 tons, length 165ft, breadth 31ft, depth 16·5ft, draught 13·5ft. The speed (under sail and steam) would not have been more than about 9 knots.

The practical success of Messrs. Cordes and Locke's experimental turbine must have raised their hopes of its application, at least as an exhaust steam turbine, to marine propulsion. No record has been found, however, that it was ever fitted into a vessel ; and so the pioneer honours for the first marine steam turbine[21] fell to Sir Charles A. Parsons at a much later date.

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Frictional Difficulty in Concrete Testing

By A. G. TARRANT, O.B.E., F.Inst.P.*

A very common criterion of concrete quality is the failing stress shown when a cubical specimen is tested to destruction in compression. The testing machines used for this purpose are usually simple presses, either hydraulic or screw-operated, and present no difficulty in their construction and use. It has been found, however, that if the same concrete is tested in two different machines the results are not always in complete agreement, even though both machines are correct when calibrated against the same proving ring. One possible cause of difference has been found to lie in the varying freedom with which the machine platens can tilt during the course of a test ; the effect of altering this freedom has been found, in some cases, to be unexpectedly large.

THE recognised procedure for concrete testing is laid down in B.S. 1881 : 1952, wherein it is specified that one of the machine platens must rest on its abutment through a spherical seating, the centre of the sphere being at the middle point of the platen face. Such a "ball-seating" is intended primarily to allow the platen to tilt on first contact with the specimen, so that it may bear evenly over the surface, even though the two opposite faces of the cube are not mathematically parallel. It will also allow the platen to tilt to some extent during the course of the test, so as to allow the platen to bear more or less evenly over the surface of the specimen, even though the two sides of the latter may have different elasticities and may therefore yield at different rates.

There is normally no doubt about the initial tilt, when the platen first makes contact with the specimen. At that moment there is no appreciable force being transmitted through the ball-seating because the platen is merely held up to its abutment by comparatively light springs, and so the mating faces of the seating can slide over each other very easily. The effort to tilt the platen will not impose any appreciable forces on the specimen. As soon as any load is applied to the specimen the picture becomes very different. The total load, up to perhaps 50 to 100 tons or more, is transmitted from one face of the seating to the other, and the ability of the platen to tilt depends upon the freedom of one face to slide over the other, when the faces are pressed together by a very large force. The freedom with which the platen can tilt depends, therefore, upon the coefficient of friction between the mating forces of the seating, when strongly pressed together. Earlier work† has shown that this coefficient of friction may have any value from about 0·6 down to about 0·04, according to the condition of the surfaces and the lubricant used. The question therefore arises : has a difference in the coefficient of friction, within this range, any measurable effect on the failing stress of the concrete as measured by the machine ?

To answer this question the same hydraulic testing machine was used as had been used for the earlier friction measurements (loc. cit.), the ball-seating of which had been brought very carefully to the best attainable perfection of form and finish. With this machine the coefficient had been found to be about 0·5 when using a mineral oil lubricant, and about 0·04 when using a special highly polar grease. The maximum capacity of the machine was 60,000 lb—a rather lower value than was really desirable, but it was obviously necessary to use a machine in which the characteristics of the ball seating were well known.

Three representative concretes A, B and C, were made, having the compositions by weight as given in Table I, using ¾in. Thames gravel, Thames sand and ordinary Portland cement. The concretes were mixed in an open-pan mixer and, from each of the three concretes, twelve 4in cubes were made from the same batch. The cubes from each batch were numbered in sequence as they were made, and all cubes were made on the same day. They were stored in water at 62 deg. Fah. for seven days, being kept in water until immediately before testing ; all testing was done on the same day, by the same experienced operator. The cubes were taken from their water storage at random, and Table I shows that their serial numbers were well distributed between the different conditions of test.

Before the test began the ball-seating of the machine was dismantled and the faces were washed with petroleum and with ether to remove all traces of previous lubricants. They were then oiled with clean mineral oil and the seating reassembled ; the coefficient of friction was measured, nine separate determinations between half and three-quarters full load giving a mean value of 0·48, with extreme values of 0·46 and 0·51, and giving no indication of either increase or decrease with increasing load. Six cubes of each concrete were then tested. The seating was then again dismantled, the faces wiped clean and re-lubricated with Shell "Livona Grease No. 3," and the seating reassembled. (Earlier work had shown that this grease, which contains a slight excess of fatty acid whose molecules are highly polar, gave a coefficient of friction of about 0·04). The remaining six cubes of each concrete were

* Road Research Laboratory, Department of Scientific and Industrial Research.

† Tarrant, A. G. : "The Measurement of Friction at Very Low Speeds. THE ENGINEER, 1954, 198 (5143), 262–3.

then tested. All the test results are given in Table I.

It will be seen from Table I that, within each set of cubes, the results are reasonably consistent: the variation between individual cubes is such as is normally found in cubes made and handled with adequate care. But in the case of concrete A there was a very marked difference in the failing strength as given by the machine when lubricated with oil and that given when grease was used. This difference is much too large and too consistent to be written off as accidental and there can be no doubt whatever as to its reality. In the case of concrete B the machine was not able to reach the failing load in the case of eight of the twelve cubes, but with three of these the failing stress could be determined from measurements of the velocity of sound in the specimen, within an accuracy of 100 lb per square inch; values obtained in this way are marked with an asterisk. The mean failing stress of concrete B is not therefore known with the same precision as that of concrete A, but the difference in the indicated failing stress produced by a change in the lubrication is marked, and is in the same direction. With concrete C the change of lubricant produced a less marked effect and, if anything, the effect is in the opposite direction.

TABLE I—*Compression Test Results*

Concrete		Failing stress (pounds per square inch)		
			Lubrication of platen	
Composition by weight	Appearance	Cube No.	Oil	Grease
A Cement 1·0 Sand 3·5 Gravel 6·5 Water 0·9	Lean, workability "low" to "medium"	1	—	1830
		2	—	1840
		3	2100	—
		4	—	1530
		5	2410	—
		6	2060	—
		7	2190	—
		8	—	1930
		9	2210	—
		10	2330	—
		11	—	1800
		12	—	1840
			Mean 2220	1790
B Cement 1·0 Sand 3·0 Gravel 5·5 Water 0·65	Lean, workability "low"	1	—	3810*
		2	3940*	—
		3	—	3500
		4	3720	—
		5	(3750+)	—
		6	—	(3750+)
		7	(3750+)	—
		8	—	3430
		9	(3750+)	—
		10	—	3590
		11	—	(3750+)
		12	4000*	—
			Mean 3890†	3590‡
C Cement 1·0 Sand 2·2 Gravel 4·3 Water 0·65	Normal, workability "medium"	1	2900	—
		2	—	3100
		3	—	3000
		4	3000	—
		5	—	3290
		6	—	3190
		7	2890	—
		8	—	2820
		9	3190	—
		10	3060	—
		11	—	3100
		12	3020	—
			Mean 3010	3080

* See text.
† Mean of three results.
‡ Mean of four results.

The magnitude of the effect in the case of concrete A is somewhat disturbing. The difference in the failing stress is not that given by two different machines handled by two different operators, where several causes for difference might exist, but is a difference in the failing stress as indicated by the same machine, handled by the same operator, on the same day, the only difference being the particular lubricant used in the ball seating. This difference alone produced the large differences of failing stress shown in Table I. Whatever cause or causes may be adduced to account for this difference, its existence is an objective fact, of which due account must be taken in concrete testing.

It may be permissible, however, to consider whether any of the known properties of the different concretes can provide a reasonable explanation. With all concrete cubes there may be differences both in strength and in elasticity between the top and the bottom of the cube. Any undue proportion of water voids or air voids will give a concrete of lower strength and lower elasticity, whilst any undue congregation of large stones will give a concrete of lower strength, but higher elasticity. In the case of concrete A, there was every likelihood of the top containing excess water, with an undue proportion of water voids. Its strength and its elasticity would both be lower at the top than at the bottom of the cube. The cubes were, of course, tested on their sides, and one side of the cube as tested would therefore be of lower elasticity, and under a stiffly moving platen its greater yield would reduce the stress upon it below that carried by the rest of the cube. If it be taken that the cube fails when its weakest part reaches a definite failing stress, then this stress will not be reached on the weaker side until a greater stress is being carried by the rest of the cube, and the total failing load will be unduly high. Under a freely moving platen, on the other hand, the stress will be distributed evenly over the cube, the weaker side will have to carry its due quota of load, and its failing stress will be reached when the rest of the cube is carrying the same stress—the total load will therefore be less than that with a stiffly moving platen. The same effect would be expected with concrete B, but, since this had a lower water/cement ratio, the effect would be less marked. Concrete C was of a type in which segregation is very likely to occur, large stones being clustered together at the bottom of the cube. Lower strength will then be associated with a higher elasticity, and a stiffly moving platen will subject the weaker side to an unduly high stress, so that failure would occur at a lower total load than with a freely moving platen. As, however, the strength-difference due to segregation will be less marked than that due to water/voids, the effect will be less marked than with concretes A and B.

In view of the large effect produced by a mere change in the lubricant, it may be thought strange that, up to now, greater differences have not been found between the results given for the same concrete when tested in different machines. The effect is not, however, so marked in some concretes, and not all concretes are sufficiently uniform in themselves to render the effect noticeable, even though it may be actually there (and, of course, many concretes are only tested on one machine). An important reason why the effect has not been noticed is that a desirably low coefficient of friction can only be obtained in a machine whose ball seating is of adequate area, and finished to the highest obtainable perfection of form and surface finish, and if a highly polar lubricant is used. Any ball seating of indifferent finish or too small, or when a plain mineral lubricant is used, will have a coefficient of friction of the order of 0·5, so that many machines will have, in fact, about the same platen friction.

It is too early to say what effect these results may have on the technique of concrete testing. Clearly, if the same machine, provided with a very excellent ball seating, can give such different results according to the lubricant used, then the requirement of B.S. 1881, that a spherical seating shall be provided, is not enough to ensure even a reasonable consistency in testing conditions. It is not easy to lay down ways in which the necessary freedom of platen movement can be specified or ensured by test, or what tolerances can be allowed, but either these questions call for solution or some other type of floating platen will have to be found.

The writer's thanks are due to his colleagues who assisted in this work, and to the Director, Road Research Laboratory, for permission to publish this article.

Peninsular and Oriental Liner "Iberia"

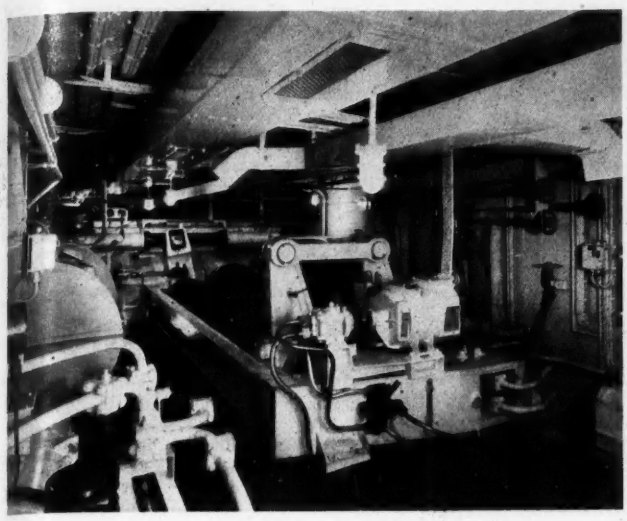
No. II—(*Concluded from page* 770, *December 3rd*)

The "Iberia" is the second liner to be completed for the Peninsular and Oriental Steam Navigation Company this year. This latest addition to the fleet is a twin screw geared turbine passenger and cargo liner, having a length overall of about 718*ft* 9*in and a gross tonnage of approximately* 28,000. *There is accommodation for a total of* 674 *first-class and* 733 *tourist-class passengers, and two sets of geared turbines, which take steam at* 500 *lb per square inch and* 800 *deg. Fah., develop a normal power of* 34,000 *s.h.p. to maintain a service speed of* 22·5 *knots.*

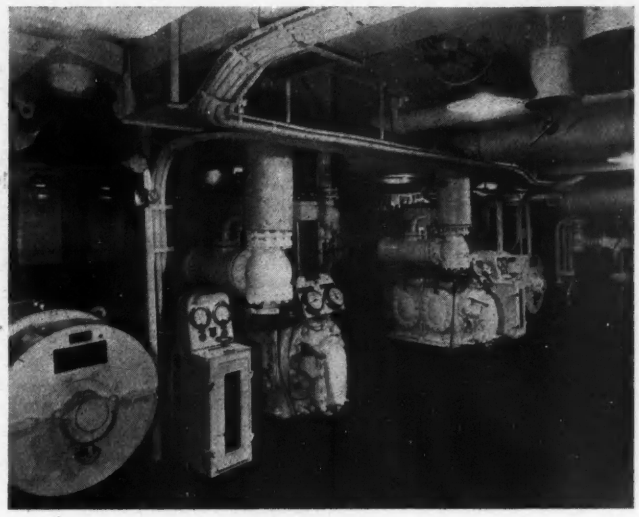
Ship Services and Auxiliary Machinery

THE galley, pantries, bakery and associated food preparation rooms are all placed on "D" deck, between the first-class and tourist-class dining-rooms, and have been carefully planned for efficient working. Henry Wilson and Co., Ltd., has provided the main equipment consisting of electric ovens, hot presses, &c., while the Hobart Manufacturing Company, Ltd., has supplied the domestic machines. A large compartment at the aft end of "D" deck houses the laundry equipment, which is of adequate capacity to meet all the requirements of the hotel services, passengers and crew. Most of the machines were supplied by Isaac Braithwaite and Sons, Ltd., and includes a 120in calender machine manufactured by Manlove Alliot and Co., Ltd.

In addition to the hospital wards, operating room and dispensaries to port on "C" deck, there are tourist general hospitals, a crew's hospital and isolation hospitals situated in a separate house aft on "B" deck. Special attention has been paid to the ventilation of the accommodation, which has been the responsibility of Thermotank, Ltd. Heating of the first-class accommodation is by electric heaters and hot air is used in the tourist accommodation, while air conditioning is arranged for the dining-rooms, first-class shopping centre, first-class ironing rooms, purser's bureau, and crew's mess rooms. For the convenience of the first-class passengers there are two lifts which rise from the lobby outside the dining-room on "D" deck through five decks to the entrance opposite the observation room at boat deck level. The tourist passengers have the services of one lift which rises from the baggage lobby on "G" deck to the promenade deck, and for the convenience of the ship's engineers there is a lift which travels down to the engine-room from "C" deck. Two baggage lifts, one to port and one to starboard, extend from the first-class entrance forward on the promenade deck down to "G" deck, and there are two stores lifts which link the store rooms on "F" and "G"



Stabiliser compartment showing the operating gear for one of the fins



Main refrigerating machinery room

decks with the stores entrances placed to port and starboard on "D" deck. A service lift connects the laundry on "D" deck with the linen room on "F" deck, and another lift is used to raise stores from "E" deck to the galley on the deck above, while there are two lifts which link the galley to pantries on "C," "B" and "A" decks for cabin service.

Besides providing the lighting for principal passenger spaces The General Electric Company, Ltd., has supplied automatic and manual telephone exchange equipment, together with about 500 telephone instruments, and its plural starter system for the engine-room auxiliaries. The four automatic units provide 117 lines for staff intercommunication and the two-position manual board has a maximum capacity of 600 lines.

A total of six hatches, all fitted with hinged steel covers, of which four are flush with the deck and wood covered, give access to the general and insulated cargo holds and 'tween decks. The cargo is handled by a total of sixteen 3-ton and two 10-ton tubular steel derricks mounted on the foremast and derrick posts and operated by eighteen Clarke Chapman electrical winches, capable of handling 3 tons at 100ft per minute, some of them having local control and the remainder being arranged for remote control. On the forecastle is a Clarke Chapman electric windlass which also drives two capstans by means of layshafts. The windlass has a capacity of 90 tons at 10½ft per minute and each capstan 19½ tons at 45ft per minute, while right aft on "C" deck are two self-contained capstans.

The refrigerated stores are arranged on "F" and "G" decks aft of No. 3 hold, and numbers 1, 2 and 3 holds and number 2 and 3 lower 'tween decks are insulated for refrigerated cargo, representing a total of 147,750 cubic feet. The insulation of the spaces has been the responsibility of the Mersey Insulation Company, Ltd., and J. and E. Hall, Ltd., has supplied the main refrigeration machinery which is accommodated in a compartment on the tank top immediately below the insulated store-rooms.

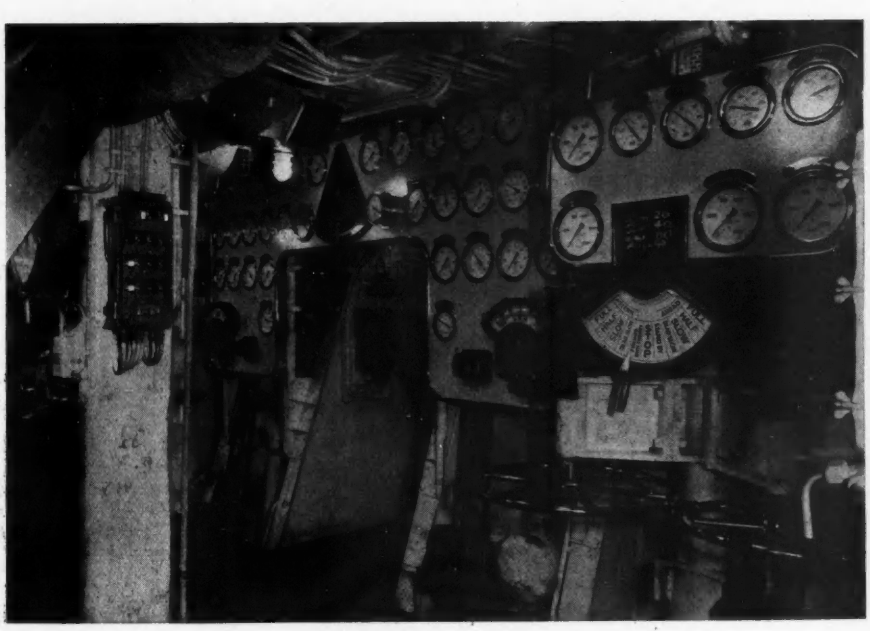
The ship is steered by a stream-lined, partially balanced rudder operated by telemotor controlled electric-hydraulic steering gear supplied by Brown Brothers and Co., Ltd. This company has also equipped the ship with its Denny-Brown stabilisers which are housed in a compartment, illustrated above, immediately forward of the boiler-room. Adams Hydraulic, Ltd., has been responsible for supplying and installing the sewage plant.

Adequate fire prevention equipment is installed throughout the ship, including a Mather and Platt fire-extinguishing sprinkler system, "Dreadnought" fire-resisting doors, fire-resisting bulkheads of "Marinite," while Newalls Insulation Company, Ltd., has been responsible for the heat insulation of the engine and boiler casings and other parts of the ship and for the sprayed limpet asbestos insulation on fire-resisting bulkheads. There is also a Walter Kidde smoke-detecting installation and Pyrene foam equipment. The water-tight doors were supplied by Mechans, Ltd., and J. Stone and Co., Ltd., has provided its electric control system for the power operated doors. For life saving purposes the ship carries a complement of twenty-two aluminium alloy lifeboats, built by Mechans, Ltd., under Welin-Maclachlan davits, and the total includes six 36ft boats to carry 145 persons each; four 31ft boats each taking ninety-nine persons, all ten lifeboats being equipped with Fleming gear; four 26ft nested rowing lifeboats, each capable of taking fifty-six persons; two 36ft Class "A" motor lifeboats, each taking 136 persons; four 38ft launch lifeboats with accommodation for eighty persons each, and two 26ft emergency rowing lifeboats, each able to carry forty-seven persons. Welin-Maclachlan Davits, Ltd., has manufactured the telescopic aluminium alloy accommodation ladders and the Tyne Gangway Company, Ltd., has provided the self-levelling hardwood accommodation ladders. The ship carries a comprehensive installation of Sperry navigational equipment, Marconi radio, radar and other electronic navigational aids and Kent clear view screens.

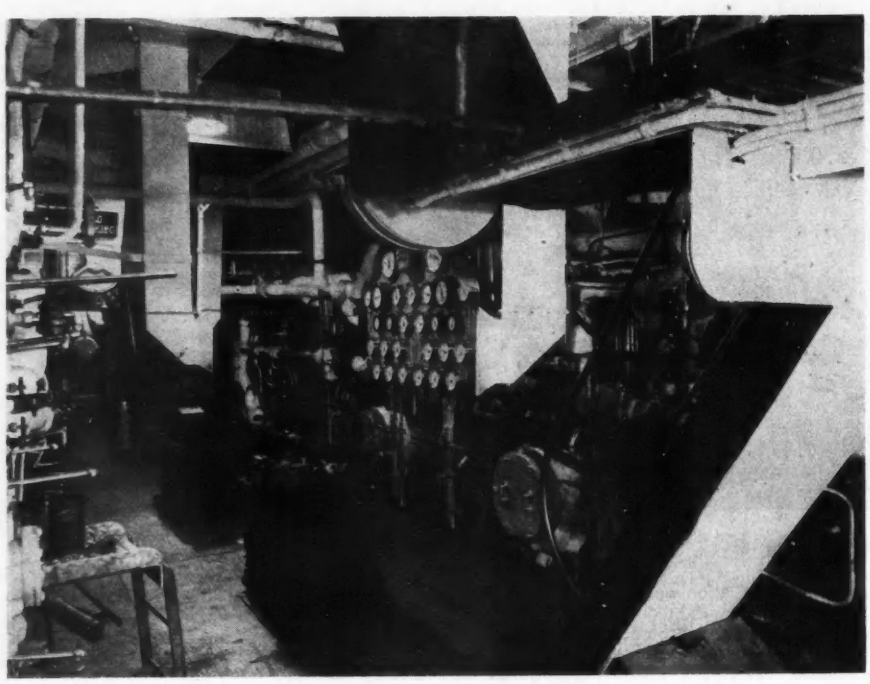
Main Propelling Machinery

Harland and Wolff, Ltd., has built the main propelling machinery for the ship and has had the overall responsibility for the complete installation. We reproduce a drawing on page 805 giving a longitudinal section through the machinery spaces and a photograph of the main control platform. Two sets of impulse reaction geared turbines of Parsons pattern propel the ship and together develop a normal ahead power of 34,000 s.h.p. at propeller revolutions of 130 r.p.m. and an overload power of 42,500 s.h.p. at 140 r.p.m. of the propeller. When going astern the power available is 22,000 s.h.p., which is 65 per cent of the normal ahead power. When developing normal power steam is supplied to the turbines at 500 lb per square inch gauge and 800 deg. Fah.

Each set of propelling machinery consists of h.p., i.p. and l.p. turbines working in series in which the h.p. turbine, of impulse-reaction design, has two rows of impulse blading followed by twenty-nine rows of end-tightened, segmentally fitted reaction blading. The impulse wheel, of forged steel, is forged solid with the rotor, and the casing is of molybdenum cast steel. Thirty-five rows of end-tightened reaction blading, segmentally fitted to the drum pattern rotor, form the i.p. turbine, which has a casing of cast steel and is arranged to incorporate the h.p. astern turbine, which has three rows of "Hecla A.T.V" impulse blading and is shrunk on to the forward end of the i.p. rotor. The double-flow l.p. turbine has eleven rows of reaction blading,



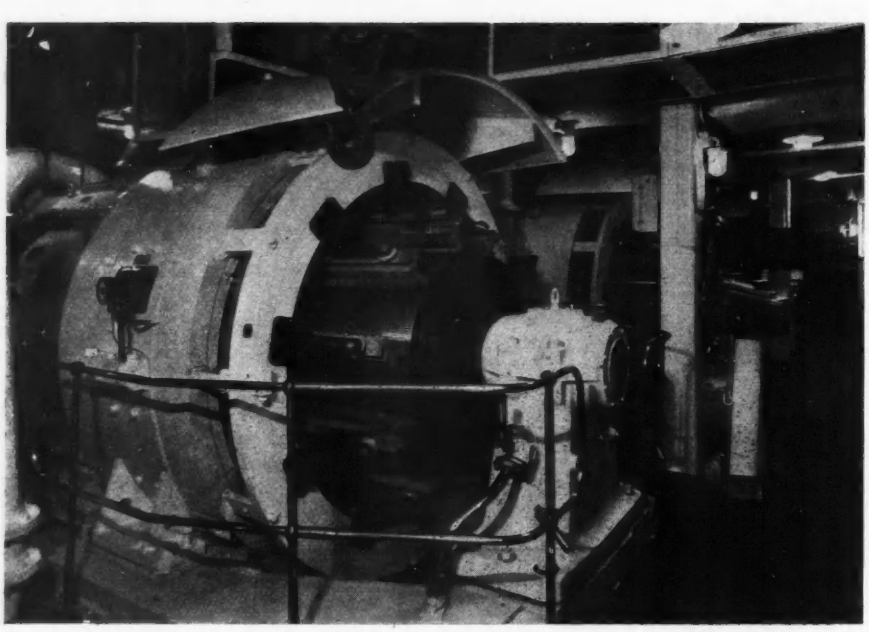
Main control platform in the engine-room, looking aft



The stokehold, showing boiler fronts

in each half, segmentally fitted to a drum pattern rotor of forged steel, and is arranged to take the l.p. three-row impulse astern wheel at the forward end. The ahead casing is of cast iron and the astern part is of cast steel. Nozzle plates for the h.p. ahead turbine are of fabricated construction and those for the h.p. and l.p. astern turbine are of cast steel, while all the nozzle vanes are of "Hecla A.T.V." steel. This steel has been used for the impulse blading and Monel metal for the reaction blading. Michell thrust bearings are fitted to all the turbines and each casing has steam glands at each end connected to the glands condenser.

Each turbine is connected to the gearing by a flexible claw coupling and the gearing, of double helical pattern, consists of a double reduction at the h.p. turbine and single reduction at the i.p. and l.p. turbines. The h.p. primary gears are housed in an independent fabricated steel gear case and consist of chrome molybdenum steel pinions of 13·71in pitch circle diameter having all-addendum teeth, a face width of 31in and a 3in gap. The mild steel primary wheels have a pitch circle diameter of 34·49in. For the h.p. turbine the pinion has a pitch circle diameter of 17·03in and the corresponding diameter of the pinions for both the i.p. and l.p. turbines is 12·62in and all are of chrome molybdenum steel. The main wheels have a 174·09in pitch circle diameter and a 49in face width, and consist of mild steel rims shrunk on to cast iron centres. The gear ratios reduce the speed of the h.p. turbines running at 3343 r.p.m. and the i.p. and l.p. turbines running at 1793 r.p.m. to 130 r.p.m. at the propeller. Electrically operated turning gear is provided and a system of forced lubrication is maintained by three "Vertoil" electrically driven pumps, two working and one standby, each having a capacity of 25,000 gallons per hour against a discharge pressure of 55 lb per square inch. Each pump draws oil through a magnetic strainer and delivers through an Auto-Klean "Flush Flo" strainer and one of three Serck oil coolers to a gravity tank which has a capacity sufficient to ensure a five minutes' supply of oil to the turbines and gearing in the event of the failure of the pumps. There are also two electrically driven Ferguson and Timpson oil purifiers, each of 350 gallons per hour capacity and associated with an oil heater. Michell thrust blocks take the propeller thrust and Michell bearings carry the solid forged steel shafting which has intermediate shafting of 21⅞in diameter and propeller shafts of 23⅜in diameter. The engine builders manufactured the solid four-bladed manganese bronze propellers, which have a diameter of 18ft 9in and a mean pitch of about 19ft 4½in.



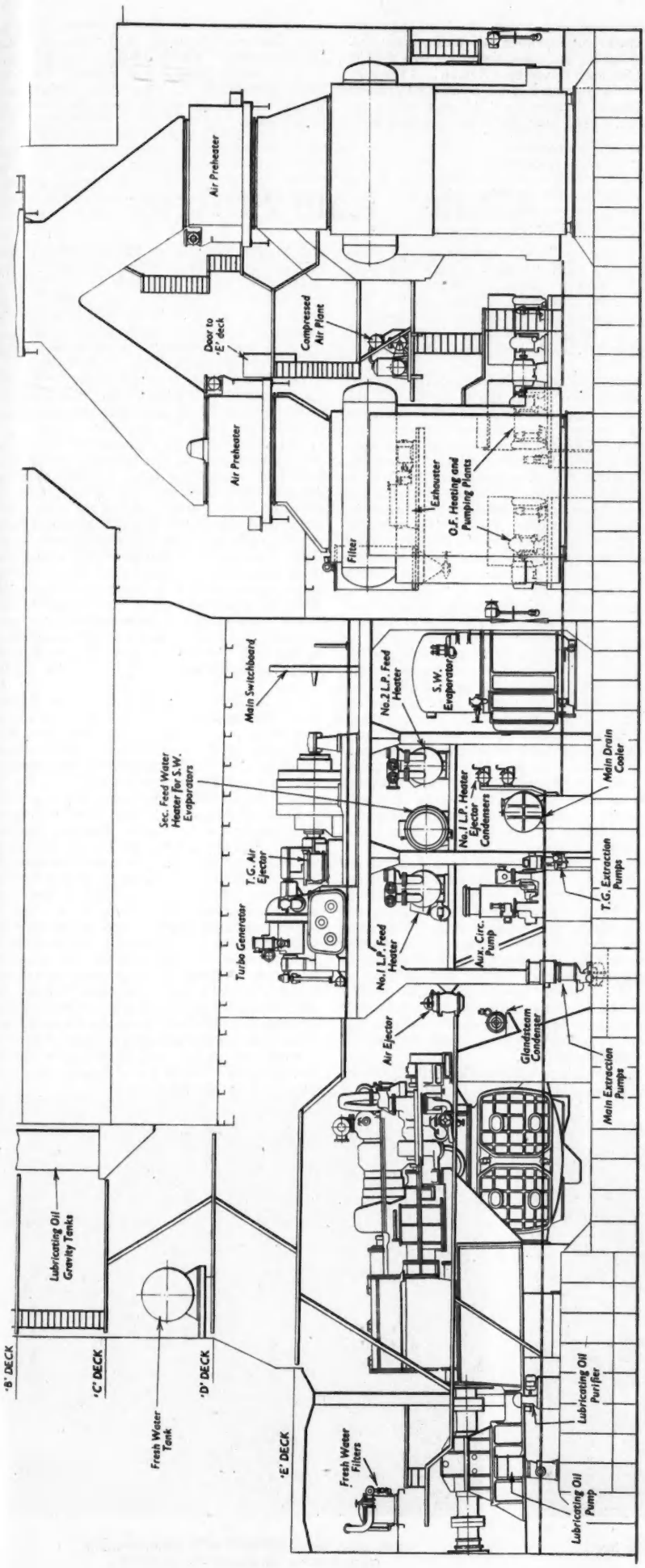
Part of generator room showing the three 1200kW generators

Boiler Plant and Closed Feed System

All the steam necessary for the working of the machinery is supplied by three two-furnace, high-pressure, water-tube boilers constructed by the engine builders to the designs of Foster Wheeler, Ltd. An illustration gives a general view of the stokehold. The steam pressure and temperature at the superheater outlet are 530 lb per square inch and 850 deg. Fah. respectively, and the superheat can be controlled down to 600 deg. Fah. when manœuvring. Each boiler has a maximum continuous evaporation rate of 165,000 lb of water per hour and is equipped with a Foster Wheeler economiser having a surface of 6250 square feet, a feed inlet temperature of 280 deg. Fah. and an outlet temperature of approximately 400 deg. Fah. The boiler and the water-wall have a heating surface of 14,105 square feet and the superheater has a surface of 2525 square feet, and each boiler is fitted with a Howden-Ljungstrom air preheater to give a funnel temperature of 280 deg. Fah. Under normal service conditions, each of the boilers has an evaporating rate of 105,000 lb per hour. Clyde electrically operated steam soot blowers, controlled from a central board, form part of the equipment of the boilers and economisers, and also the air preheaters. "Igema" water-level indicators and Mono CO_2 recorders have been supplied by James Gordon and Co., Ltd., and Cockburns, Ltd., has provided the main steam stop valves, safety valves, manœuvring valves, valves for boiler mountings, &c. British Vacuum Cleaner Industrial Constructions, Ltd., has supplied the soot removal plant, which has a motor-driven turbo twelve-stage exhauster and dry separation unit. Alexander Stephen's low-water level alarms are fitted and also electric salinometers and a boiler densometer equipment manufactured by W. Crockatt and Sons, Ltd., while "Alfloc" water testing equipment is installed, together with water-treatment pumps and "Belloid" injection pumps, by the Candy Filter Company, Ltd.

Wallsend Slipway and Engineering Company, Ltd., has supplied three "Simplex" oil fuel installations, two working and one standby, and each of the electrically driven, two-throw, pumps can deliver 13,500 lb of oil fuel per hour at a pressure of 300 lb per square inch through a heater to the burners. In addition there is a single-throw pump and an 18kW heater for lighting-up purposes. For the transfer of oil fuel there are two 100 tons per hour, two-throw, double-acting reciprocating pumps. The boilers operate under Howden's system of balanced forced draught and for each boiler there is a double inlet forced draught fan, driven by a 151 b.h.p. motor, and rated to deliver 60,000 cubic feet of air per minute at 80 deg. Fah. against a pressure of 10in water gauge. The associated single inlet induced draught fan is driven by a 400 b.h.p. motor and can deal with 92,000 cubic feet per minute of gas at 340 deg. Fah. against a pressure drop of 15·5in water gauge.

A Weir two-flow regenerative condenser is bolted to the underside of each l.p. casing and has a cooling surface of 17,500 square feet. Each is designed to condense 134,000 lb of steam per hour and to maintain a vacuum of 28·85in with sea-water at a temperature of 65 deg. Fah. when the machinery is developing a maximum of 42,500 s.h.p. or 28in with the sea temperature at 86 deg. Fah. with the machinery the normal service power of 34,000 s.h.p. The condenser body is of mild steel with Muntz metal tube plates and cupro-nickel tubes. There are two Allen pumps, each powered by a 155



Longitudinal elevation showing general arrangement of engine and boiler-rooms

b.h.p. motor, for circulating each condenser, and each pump has a capacity of 12,000 gallons per minute against a head of 26ft. Two closed feed controllers are fitted, each having a 6in supplementary feed valve and a 4in float-operated overflow valve, and they allow water either to be drawn into the condenser from the main feed tank should a sudden demand for water cause the level in the condenser to fall, or to be discharged to the main feed tank should the water level rise in the condenser. To serve each condenser there are two Weir "Lo-Hed" electrically-driven two-stage centrifugal extraction pumps, one working and one standby, each having a normal service capacity of 198,650 lb of condensate per hour and a maximum of 258,000 lb per hour against a head of 30 lb per square inch.

On its way to the boilers the condensate passes through a three-stage air ejector, a glands steam condenser having a surface of 80 square feet and a single drain cooler having 800 square feet of cooling surface. The condensate is delivered to the boilers by Weir turbine-driven, two-stage, centrifugal feed pumps of which there are three, two working and one standby, each rated to deliver 350,000 lb per hour of feed water against a pressure of 725 lb per square inch under normal conditions or 400,000 lb per hour on overload. The pumps discharge through the first four-flow l.p. feed heater, which has a surface of 950 square feet and which is fitted with a single-stage air ejector and two condensers. Next, it passes through the second l.p. heater of 1050 square feet surface area to a four-flow h.p. heater having a surface of 770 square feet, from which the feed water leaves its final temperature of 280 deg. Fah. The feed system includes a Weir "Optimum" de-aerator having a capacity of 125,000 lb per hour of feed water at sea or 66,000 lb per hour under harbour conditions. The unit is complete with its own air ejector, devaporiser, extraction and supply pumps.

In addition to the main feed pumps there are a harbour service Weir turbine-driven, three-stage centrifugal feed pump of 50,000 lb per hour capacity and a Weir "Electro" feeder, a nine-stage rotary pump, capable of delivering 52,000 lb per hour against a discharge pressure of 725 lb per square inch. An auxiliary feed heater is also installed having 190 square feet of heating surface and a duty of 50,000 lb per hour.

Distilling Plant and Auxiliary Machinery

A sea-water evaporating and distilling plant is installed in the engine-room to produce single distilled water to meet domestic requirements and double distilled water to provide make-up feed water for the boilers, so that the amount of fresh water carried in the ship is reduced to a minimum. In the arrangement the first l.p. feed heater condenses the vapour from the sea-water evaporators so that the heat used in evaporation is recovered in the boiler feed water. Part of the condensate is passed to the domestic fresh water tanks through a cooler and the remainder is pumped to the fresh water evaporator as feed. The vapour from the latter is condensed in the second l.p. heater and the condensate led to the main drain cooler. The capacity of the sea-water evaporators, when working in double-effect, is 550 tons of distilled water per day and the plant, manufactured by G. and J. Weir, Ltd., consists of six salt water evaporators each of 1050 square feet surface area, three working as first effect and three as second effect units. There are also one distilled water cooler and primary feed heater having a surface area of 900 square feet; a secondary feed heater of 1000 square feet, for the salt water evaporators; feed pumps, brine pumps and fresh water pumps all electrically driven, and one fresh water evaporator having a heating surface of 300 square feet and a capacity of 75 tons per day. Then, there are two distilling condensers, for making distilled water under harbour conditions, each having a heating surface of 600 square feet and capable of handling 150 tons of vapour per day and the distilled water is passed through a cooler of 190 square feet surface area. The distilled water is limed and chlorinated and passes through filters in its passage from the coolers to the storage tanks and when used as fresh water it passes through two

units in the discharge side of the fresh water pumps, for conditioning with bicarbonates and for dechlorination.

The pumps, most of which are electrically driven and operate under the plural starter system, have been supplied mainly by W. H. Allen Sons and Co. Ltd., Drysdale and Co., Ltd., and G. and J. Weir, Ltd. Among those supplied are included two bilge pumps of 60 tons per hour against 60ft head capacity; one 250 tons per hour general service and ballast pump; two sanitary pumps rated to deliver 220 tons per hour against a head of 120ft; two bath pumps having a capacity of 60 tons per hour against a 90ft head; two fire and bilge pumps of 200 tons per hour capacity at 50 lb per square inch; and one 200 tons per hour against 60ft head bilge pump. Forming part of the sprinkler system is a Mather and Platt centrifugal pump capable of delivering 130 tons per hour at 100 lb per square inch, a pressure tank of 1000 gallons capacity and a twin-ram topping-up pump. The ship is served by the Drysdale "Pneupress" system, which incorporates two 40 tons per hour pumps delivering against a head of 222ft, and a motor-driven air compressor rated at 8 cubic feet per minute at 100 lb per square inch. Two salt water and one fresh water calorifiers were supplied by Archibald Low and Sons, Ltd., each of 5600 gallons per hour capacity and a temperature range from 50 deg. to 180 deg. Fah. There are also smaller calorifiers for galley and laundry. A "Victor" oily water separator of 50 tons per hour capacity is provided, and a Broom and Wade air compressor for boiler cleaning purposes.

To ventilate the engine, boiler and generator rooms are a number of axial-flow fans manufactured by Thermotank, Ltd., and air is supplied to the engine-room by two 25in fans of 7000 cubic feet per minute capacity, two 17,000 cubic feet per minute 40in fans and two 47½in fans rated at 28,000 cubic feet per minute, while the air is exhausted by two 30in fans of 10,000 cubic feet per minute capacity. There are two 30,000 cubic feet per minute 45in supply fans and four exhaust fans of similar capacity to ventilate the boiler-room and, in addition, there are two supply and one exhaust 22½in fans of 4000 cubic feet per minute capacity. Two 35in, 20,000 cubic feet per minute fans serve the generator room and one 18in fan meets the requirements of the emergency generator room.

In the generator room are three 1200kW B.T.H. 225V d.c. turbine-driven generators, illustrated on page 804, which meet the overall demands of electrical power of the various ship's services. The turbines run at 5500 r.p.m. and drive through single reduction, double helical gearing to give a speed of 600 r.p.m. at the generator, and all three generating sets have their own self-contained condenser, closed feed control, air ejector and separate extraction pumps and take steam at about 500 lb per square inch and 850 deg. Fah. Each of the three "LoHed" extraction pumps has a capacity of 20,000 lb per hour and there are two auxiliary circulating pumps, each rated at 8500 gallons per hour, one feed water circulated auxiliary drain cooler and another salt water circulated. For emergency purposes there are two 100kW generators, each driven by a Ruston and Hornsby diesel engine mounted in the emergency dynamo room located forward on "B" deck under the forecastle. Mawdsley, Ltd., has supplied three motor alternators for the fluorescent lighting, and Chloride Batteries, Ltd., has provided the emergency battery and the low-power battery, while Whipp and Bourne, Ltd., has been responsible for the main switchboard which is 47ft in length, and the emergency switchboard.

Chain Grate Stokers

THE "Oldbury" chain grate stoker for firing low-grade fuels to shell boilers has been made by Edwin Danks (Oldbury), Ltd., for several years, and more recently the firm has been producing a smaller version of this design of stoker for firing sectional hot water boilers ranging from 750,000 to 2,500,000 B.Th.U. per hour.

In these stokers the main frame of rigid welded construction also forms the air box, and the link grate is supported partly on a flat steel plate forming the air control register and partly on skid bars. No rear shaft is fitted and at the back the grate passes over curved plates. The high, thin links used for the grate are designed to expose the largest possible surface to the cooling action of the air and the smallest heat-absorbing surface to the fire bed. They are machined to close tolerances so that they can be very closely spaced and give even air distribution with the smallest losses due to riddlings when burning fines on the grate.

A geared d.c. shunt wound motor which drives the grate through worm gearing gives a smooth and practically stepless variation in speed over a wide range by a simple field control.

Each stoker is fitted with its own forced draught fan, the total air supply being controlled by a "Vortex" damper on the fan inlet. Individual fans permit precise air control to each stoker; an important factor where two stokers are fitted to a boiler, as each fan operates as a separate unit. Air is admitted at both sides of the stoker at the front, and the supply to the back of the grate is separately controlled. It is thus possible with these controls and the main air supply dampers to adjust the air requirements to suit any particular load or class of fuel.

Secondary air is provided by a duct tapped from the main air supply and admitted through ports in the firedoor. This air, in addition to assisting in the combustion of the volatile hydrocarbons, keeps the firedoor cool. The combination of controlled secondary air and the precise means of primary air control makes possible smokeless combustion with all kinds of fuel. It is possible to reverse the flow in the secondary air ports in the firedoor and withdraw hot gases from the furnace to pass over incoming fuel and facilitate the ignition of coke breeze and other low volatile fuels.

Ample space is provided underneath the stoker for ash removal, which can be carried out quickly and without shutting off the air supply or disturbing the fuel bed. When required on large installations an ash extractor can be fitted to give continuous automatic ash removal. This extractor is driven from the stoker motor and consists of a drag-link chain with scraper bars. It lies in the flue beneath the stoker and brings the ash forward to the front of the boiler.

The new "Minor" stoker made by the firm has a standard grate width of 16in and is available in two lengths, which adequately cover the range of boilers for which it is intended.

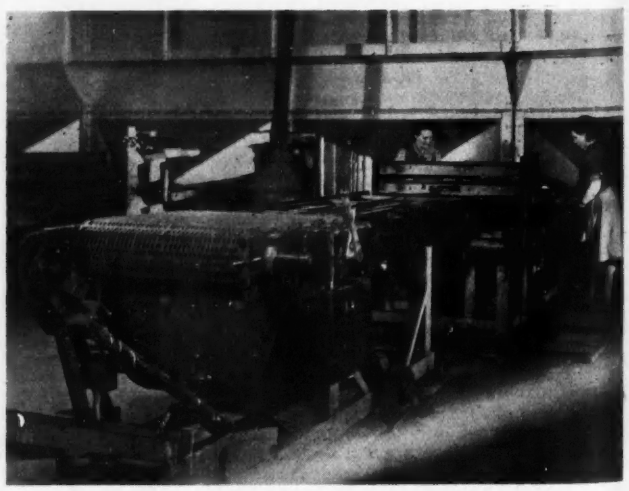
We recently had an opportunity to visit the Woodside Works of the company, which have been laid out for the batch production of the stokers. The fabricated chassis or frames are delivered to one corner of the main shop and fitted with the drive, fan and ancillary parts. At the chain assembly section, shown in the illustration on this page, the chain is assembled in an upside-down position on a large flat table. Here two operators working from each side place the links in position and insert the link rods. As assembly progresses the chain grate is pulled along the table on to the stoker frame at the end. When the grate is complete the stoker is drawn away and replaced by another frame.

The cast iron grate links, which are die cast, are drilled and faced in a separate section at one end of the shop, and some 5,000,000 links a year are handled by this section. The blanks are delivered into large hoppers, six of which are used for the common links and one for the driving links. The links are first drilled on four-station indexing fixtures and then thrown on an inclined table down which they gravitate to a line of drilling machines set up for spot facing the bosses. From the spot facing machines the links are deposited into elevators feeding into large bins which directly supply the chain assembly station.

The refractory lining is set in the arch and firedoor on the hopper sub-assembly on a roller conveyor line. A very dry mix of aluminous refractory concrete is used and mechanically tamped in position on this line. The dry mix used not only ensures good refractory qualities, but also enables the units to be handled safely within a very short time of placing.

When the stokers are completely assembled they undergo a sixteen hours' running test before being sent forward for despatch.

Batch of chain grate stokers in finishing and testing bay



Chain grates being assembled on a table and drawn on to a stoker as sections are assembled

Machinery at the Smithfield Show

No. II—(*Continued from page 773, December 3rd*)

THE Smithfield Show and Agricultural Machinery Exhibition was opened at Earls Court, London, last Monday morning and will close this (Friday) evening. Throughout the week the exhibition has been visited by large numbers of people from home and many overseas countries. Approximately two-thirds of the space available in the Earls Court exhibition hall is occupied by the display of machinery and implements covering just about every aspect of mechanised agriculture. We continue below our description of some of the new items of equipment exhibited at the show.

DAVID BROWN TRACTORS (ENGINEERING), LTD.

The wheeled tractors shown by David Brown Tractors (Engineering), Ltd., Meltham, Huddersfield, are equipped with a traction control device which the company has just introduced. From now on, this device is to be incorporated in all the company's wheeled tractors fitted with hydraulic lift. The primary purpose of the traction control system is to eliminate wheel slip without the aid of wheel weights, ballast, wheel strakes and similar arrangements. What happens is that a progressively varying proportion of the implement weight is transferred to the rear wheels of the tractor. The main component of the traction control equipment is a small adjustable valve which is built into the tractor's hydraulic system. The valve is fitted to the front offside face of the rear axle housing within easy reach of the driver. After presetting this valve at any one of twelve positions, traction control is applied by a lever which is coupled to the normal power lift lever on the offside rear mudguard. It is claimed that, with the minimum of practice, an experienced tractor driver can determine the amount of weight transfer required.

The arrangement of the system is shown diagramatically in Fig. 5. In addition to the adjustable pressure control valve *C*, already mentioned, the assembly includes a poppet shut-off valve *A*, which isolates the control valve from the hydraulic system, and a flow control valve *B*. As the control lever *F* is placed in the forward position the valve *A* is opened to the pressure line of the hydraulic system. The same action also places the hydraulic lift lever in the " lift " position, so that both the by-pass valve *G* and the main pressure control valve *H* at the pump are closed. When the valve *A* is opened, the flow control valve *B* is in the closed position and would normally control the pressure in the system. It is made inoperative as a pressure control valve, however, by drilling through the valve, permitting equal pressure on the front and back valve faces. This drilling enables a restricted pressure to be developed and to be effective on the pressure control valve *C*. The leakage of fluid past the control valve *C* slightly reduces the pressure acting on the rear face of the flow control valve *B* and slightly displaces this valve at the port *D*. When the flow control valve *B* moves sufficiently to equalise pressure on its front and rear faces, it remains substantially static and the pressure in the system is constant. In this way, pressure is applied at the hydraulic ram piston *J*, without relative movement occurring, and a static potential lifting force is produced at the lift linkage. Variation of this force, countering the weight of the mounted implement, is achieved by changing the setting of the control valve *C* by the screw *E*. When the valve spring is under maximum compression, a potential lift equal to approximately 35 per cent of the implement weight is obtained and an equivalent balancing downward force is exerted at the rear axle. The total effective force acting on the rear axle of the tractor is actually greater than the force developed by the hydraulic system, on account of the repositioning of the effective centre of gravity of the tractor and implement. In effect, therefore, there is a partial weight transfer from the front to the back axle. Thus, the total additional adhesive force acting on the driving wheels may equal up to two-thirds of the static back axle weight and is actually increased when the tractor is ascending a gradient. The makers say that with an implement weighing 800 lb the maximum effective traction force is approximately 600 lb.

New implements which are exhibited by David Brown Tractors (Engineering), Ltd., include a power ripper and subsoiler with an operating depth of from 12in to 20in, and a mounted disc plough which has been designed primarily for export. This plough (Fig. 7),

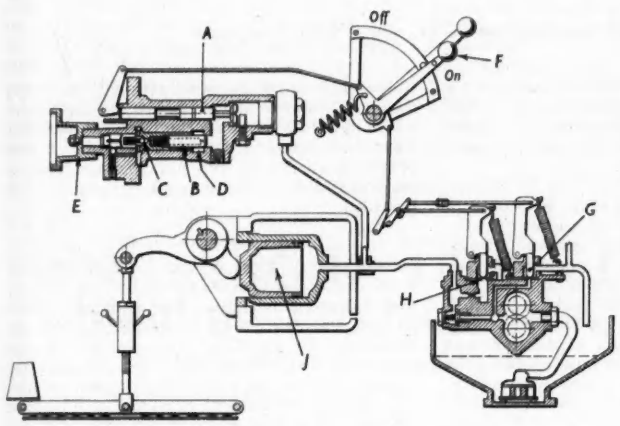


Fig. 5—Operation of traction control unit

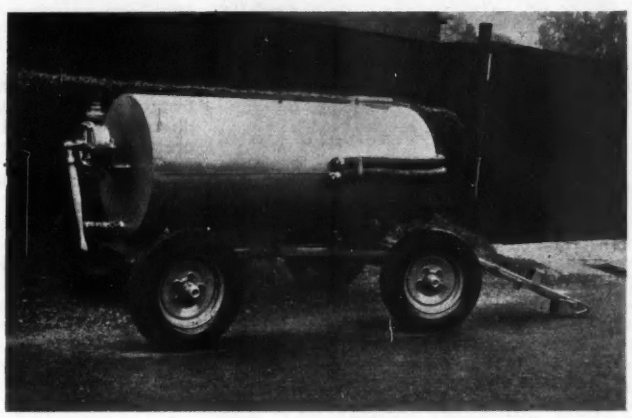


Fig. 6—Tank trailer of 300 gallons capacity

Fig. 7—Three-furrow mounted disc plough

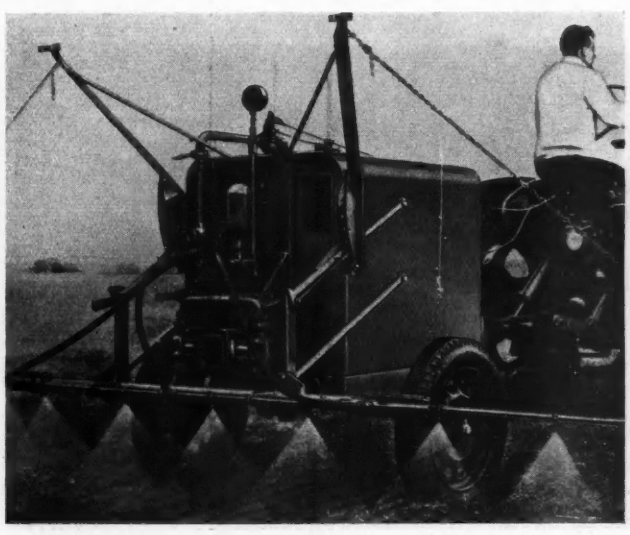


Fig. 8—Tractor-trailed medium pressure sprayer

which is normally a three-furrow implement, is assembled on a light triangular main frame, the disc assemblies being carried on a main member of heavy gauge tube. The 26in diameter discs are mounted on taper roller bearings inside cast iron hubs which are sealed against dust. The hubs can be positively adjusted in three vertical positions on their hangers, and each hanger can be clamped in any of three lateral positions on the main member according to the nature of the ground. A flanged spring-loaded thrust wheel, which is bolted to the rear disc assembly, has a three-position vertical adjustment, and can be adjusted radially by an offset cam. The depth control wheel, which can also be adjusted vertically and radially, not only determines working depth, but also assists the thrust wheel to keep the plough on its true course and ensures a constant furrow width. Both the thrust and depth wheels are of high-carbon steel and are self-sharpening; both wheels run on tapered roller bearings which are sealed against dust. The plough can be converted from three to two-furrow capacity, or vice versa, by removing or replacing the centre disc assembly. When only two furrows are required the centre disc is removed by unclamping the U-bolt from the tubular main frame, and the rear disc, with the thrust wheel fitted, is then bolted into the second disc position. There are nine settings for the discs, and levelling of the plough is achieved by the top link and levelling levers on the linkage.

County Commercial Cars (Sales), Ltd.

In Fig. 9, we illustrate a four-wheel drive tractor which is being exhibited by County Commercial Cars (Sales), Ltd., Albert Street, Fleet, Hants. This tractor, the makers say, has been produced to meet overseas requests for a machine capable of higher operating speeds than a crawler tractor but with sufficient power to attain a high drawbar performance. The engine is a "Fordson Major" diesel giving 40·5 b.h.p. at a rated speed of 1600 r.p.m. The gearbox, which is also to the "Fordson Major" specification, provides for six forward speeds, between 1·74 m.p.h. and 11·06 m.p.h., and two reverse speeds of 4·23 m.p.h. and 2·35 m.p.h. The front and back wheels are equipped with 13in by 24in pneumatic tyres, and the clutch and brake steering system has been designed to give good manœuvrability. The drive to the back axle is taken by spiral bevel gearing to the steering clutch shafts and through straight spur gears to the sprocket axle shafts. The drive to the front wheels is by chain from the back axle, the front hubs being carried on splined shafts which are mounted on heavy-duty ball bearings housed in the chain cases. The 1½in pitch A.S.A. standard chain is tensioned by an eccentrically mounted adjuster sprocket, the whole drive being totally enclosed. The front suspension incorporates a single transverse laminated spring with flexibly mounted links. The spring is fixed to the power and transmission unit by a box clamp steel cross member and heavy side

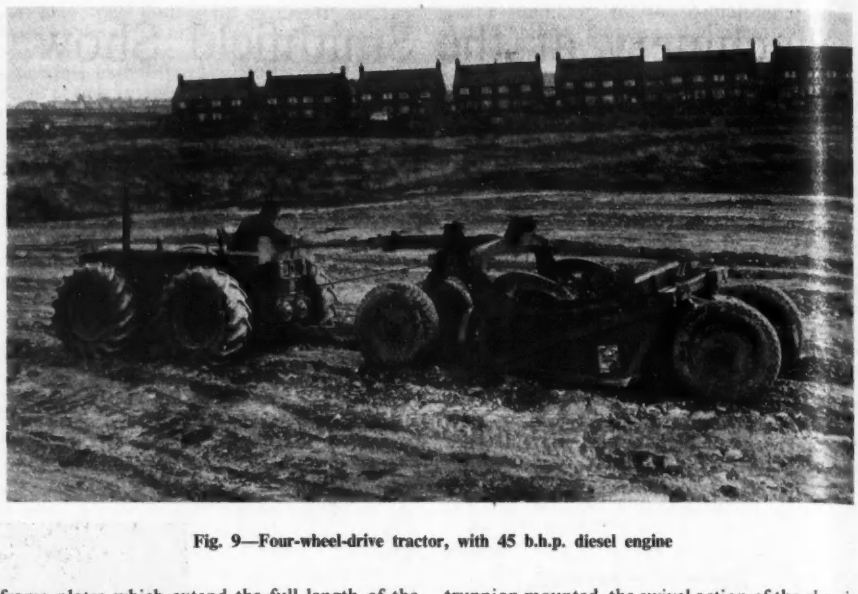


Fig. 9—Four-wheel-drive tractor, with 45 b.h.p. diesel engine

frame plates which extend the full length of the front and back transmission housings. Our illustration shows the "Fourdrive" tractor operating an "Onions" 3–4 open-bowl scraper.

Taskers of Andover (1932), Ltd.

A 300-gallon tank trailer (Fig. 6) is one of the new exhibits of Taskers of Andover (1932), Ltd., Waterloo Iron Works, Andover, Hants. The welded tank, which is 3ft in diameter by 7ft 6in long, is galvanised inside and out and reinforced internally with two bulkheads which also act as anti-surge baffles. A 1½in semi-rotary pump is mounted at the back of the tank and there are two 12ft lengths of hose enabling the tank to be filled from any convenient source. For normal discharge purposes there is a drain valve at the back of the tank, but if it should be required to discharge the contents at a higher level, the drain valve can be connected to the suction side of the pump by one length of hose, the other length being used on the delivery side. A 12in filling hole at the front of the tank has a raised collar and hinged cover secured by a swing bolt and wing nut.

The tank has been designed primarily for agricultural use and other work where speeds do not exceed 15 m.p.h., and it is therefore mounted on a pneumatic-tyred farm wagon chassis with a pivoting centre pole. The chassis consists of two flat triangular frames, each comprising a rolled steel cross member, a longitudinal pole and angle steel braces. The pivoting centre pole permits the two frames to tilt in relation to each other. As the back end of the tank is rigidly mounted on the chassis and the front end is trunnion mounted, the swivel action of the chassis comes into play at any irregularity in the ground which is being traversed, and equal load distribution is maintained on all the wheels. Brakes operating on the overrun principle are fitted to the front wheels, and a hand parking lever is provided.

Pest Control, Ltd.

Examples of most of the chemical sprayers which it manufactures are shown by Pest Control, Ltd., Bourn, Cambridge. This company, which is now associated with Fisons, Ltd., has just introduced the 150-gallon "Fieldmaster" equipment (Fig. 8), which has been designed for medium pressure spraying at high or low volume. It is suitable for use with most makes of wheeled tractors. The tank, which is carried on a strong chassis fitted with pneumatic-tyred wheels, is equipped with a mechanically driven agitator. The "Arun" gear pump, which is operated by the tractor's power take-off shaft, delivers 15 gallons a minute at a pressure of 200 lb per square inch. Provision is made for three-stage filtration of the spraying liquid, and the spray bars have interchangeable nozzles giving an application rate of 5 to 80 gallons an acre at a speed of 4 miles an hour.

Among the other equipment shown by this firm there is a "Pesco" knapsack sprayer which has been designed for smallholders and with the needs of peasant farmers in overseas countries in mind. This sprayer consists of a 2-gallon kidney-shaped can, which is carried on the operator's back, and connected to a syringe. The syringe incorporates an air pressure reservoir.

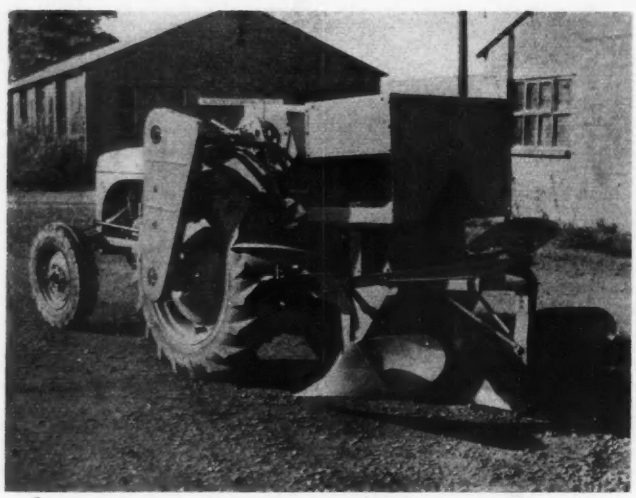


Fig. 10—Fertilizer distributing attachment to a potato planter

Fig. 11—Single-row sugar beet topping machine

MASSEY-HARRIS-FERGUSON (SALES), LTD.

A fertiliser attachment to the Ferguson potato planter is one of the new pieces of equipment shown by Massey-Harris-Ferguson (Sales), Ltd., Coventry. It is secured to the back of the tractor (Fig. 10) by a simple three-point mounting. The hopper, which holds 190 lb of granulated fertiliser, contains a forced feed delivery mechanism driven through a chain and sprockets from the nearside back wheel of the tractor and controlled by a hand clutch. By changing the sprockets on the wheel and layshaft, alternative sowing rates between 4¼ cwt to 33 cwt of fertiliser can be obtained. Agitator plates which are fitted within the hopper prevent the fertiliser bridging over the feed mechanisms, so that a constant distribution rate is maintained. The fertiliser is delivered from the hopper through flexible rubber tubes into placement coulters which are situated ahead of the chutes discharging the potatoes, and these coulters enable the fertiliser to be distributed in bands, at a controlled depth, to one side of the seed. Special attention has been given to the maintenance of the machine; two detachable metering plates are fitted, and as they are withdrawn the fertiliser falls directly from the hopper when cleaning is necessary.

A sugar beet topping machine which has been developed by Massey-Harris-Ferguson, Ltd., is illustrated in Fig. 11. It employs an adjustable steel knife which is inclined to the direction of travel and which is carried on parallel links to ensure a horizontal cut. Guide shoes are fitted at the front of the machine to centralise it over each row of beet, and the topping is effected on what the makers call the " differential " principle. For any given rise of the feeler wheel as it moves up and over a beet, the topping knife rises a smaller, but proportional, distance, so that a fixed proportion of each beet crown is removed irrespective of the size of the plant As will be seen from the illustration, the machine, which has a chain drive, is attached to the three-point linkage of the Ferguson tractor.

R. A. LISTER AND CO., LTD.

One of the exhibits of R. A. Lister and Co., Ltd., Dursley, Glos, is a loose grain elevator, which is in fact an adaptation of the Lister " G.P.12 " general-purpose elevator, the special attachments required being a hopper and thirty-one scoops. The scoops are provided with clips to enable them to be fitted easily to the elevator bars. The hopper can be filled by shovel or, alternatively, sacks may be emptied directly into it. On the other hand, with the hopper removed, the elevator can be pushed into a heap of grain which the scoops will pick up. A feed control box assembly has been incorporated to maintain an even flow of grain to the scoops at all operating heights of the elevator, and to prevent any " throwback " from the scoops and to direct the grain accurately, a delivery chute is placed at the top of the ramp. Finally, a tray is provided to collect the initial spill from the scoops and return it to the hopper. It is stated that the elevator can handle about 10 tons of grain an hour.

(To be continued)

Short Electric Tunnel Kiln for Building Products in Uganda

By DOUGLAS BOND, B.Sc. (Eng.), A.M.I.C.E., A.M.I.Mech.E.

The Owen Falls dam, which has been built across the River Nile near its source at Jinja on the shores of Lake Victoria, has been the impetus for the increasing use of electricity in local industries in the Uganda Protectorate. This article describes the necessary factors involved in the design, construction and operation of an all-electric clay products factory, including the adaptation of a small, electric tunnel kiln for firing the wares. The blending of clays to suit firing conditions is discussed. A method of comparing temperature curves of laboratory firing tests on clays with the predicted temperature curves for an electric tunnel kiln is described. Finally, running costs are given and possible improvements to the kiln are proposed.

ELECTRIC tunnel kilns have become well established in the pottery industries. Because of the clean atmosphere in electric kilns, wares can be fired without saggers and with a low percentage of breakages among other advantages, such as the more pleasant working conditions for kiln operators.

In 1947 the Government of the Uganda Protectorate initiated the present Owen Falls scheme by which the waters of Lake Victoria are harnessed at Jinja, Uganda, to provide electricity for the industrial development of this country. Before the construction of the Owen Falls dam they plunged down a series of rapids into the River Nile on their 3800-mile journey to the Mediterranean Sea. This dam has an ultimate capacity of 150MW and will supply electricity to the various areas in Uganda through high-tension transmission lines from 11kV up to 132kV.*

There is no coal in Uganda and the 750-mile distance by rail from Mombasa, the nearest seaport, makes the cost of importing coal prohibitive. The cost of fuel oil is high due to this rail haul. Until now all kilns in Uganda for firing building products have used wood as fuel. The cost of timber fuel is continuously rising due to the increase in basic wages in this country. This trend in the cost of wood fuel and in the cost of labour necessary for attending to wood-fired kilns, together with the likely decrease in the price of electric power when the Owen Falls dam is in full operation indicated the possible economic use of electricity for firing building products.

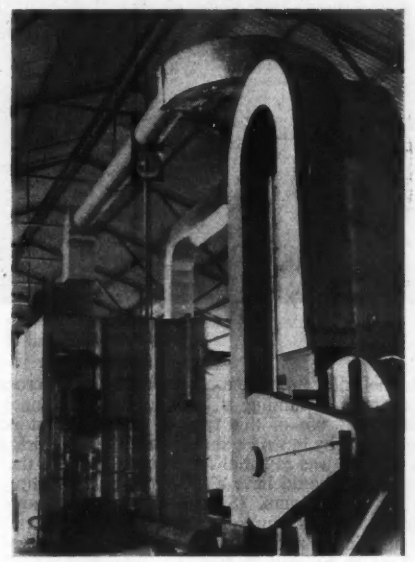


Fig. 3—Hydraulic ram circuits and recuperator ducting

As part of his development programme the director of public works of the Uganda Protectorate has constructed a factory at Jinja for producing clay building products using a small, electric tunnel kiln for firing the wares. The planning of the factory was divided into the following sections :—

(1) Specification of required products.
(2) Selection of clay and factory site.
(3) Selection of machinery and kiln.
(4) Construction of factory.
(5) Trial production.
(6) Full production.

PRODUCTS

In order to obtain a good uniformity factor of the fired products an electric radiation

* See THE ENGINEER, April 30 and May 7, 1954

Fig. 1—Interior of the kiln house at Jinja

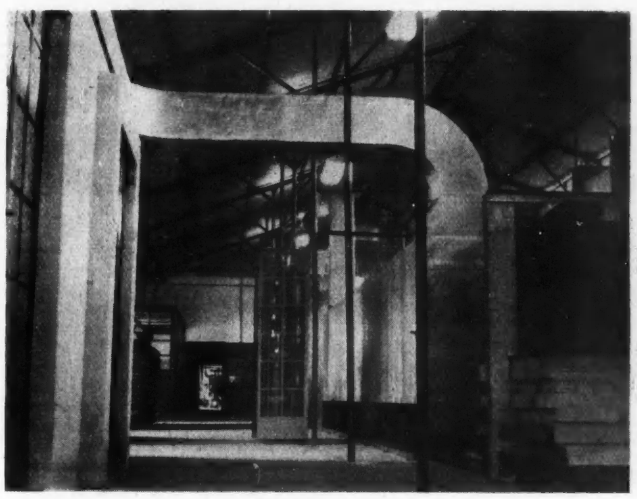


Fig. 2—Preheating tunnel of the kiln

Fig. 4—Preheating end of kiln

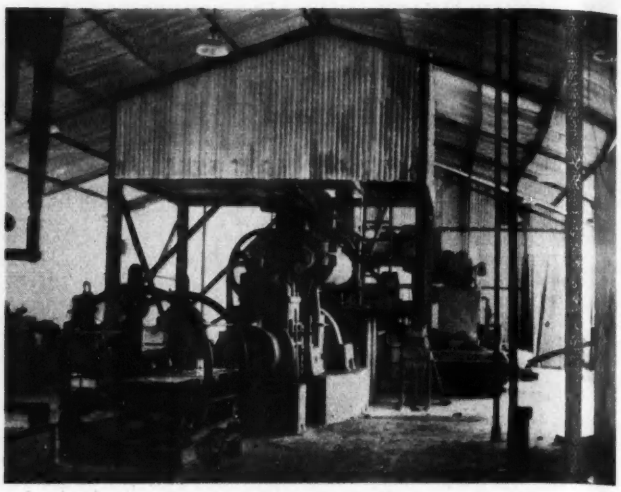


Fig. 5—Clayworking machinery

tunnel kiln must have a reasonably small cross section. Assuming a limiting size of tunnel, economic use of this type of kiln can best be obtained by having a short overall time of firing cycle. It was essential for its economic use that this kiln should have a firing cycle of not more than thirty hours. Special dies were prepared for the manufacture of roofing tiles, hollow clay wall blocks and cellular floor blocks, such as those to be seen in Fig. 7. The thickness of clay at any point was less than $\frac{3}{4}$in. The distance through which moisture could escape during firing would not then exceed $\frac{3}{16}$in. The first stage of development was to entail the minimum production of 5,000,000 lb weight of fired products per annum.

Selection of Factory Site

A suitable site had necessarily to satisfy all of the following basic requirements.

(1) The factory to be on the site of a suitable clay deposit.

(2) Economically near electricity and water supply.

(3) Easy transport of products to all parts of Uganda.

It was necessary to find a clay which would, for economic reasons, vitrify sufficiently at a reasonably low temperature. In addition, it should have a low permeability, high strength and attractive colour. It should also have sufficient porosity to allow its moisture to escape without bursting the clay, especially when subjected to a firing cycle of short duration.

Samples of clay from various parts of Uganda were prepared in the laboratory in a manner which simulated the action of the full-scale clay-working process suitable for the clays investigated. Specimens 3in square and $\frac{1}{2}$in thick were prepared and fired at different temperatures. The large number of recognised tests was reduced to two major tests for the purposes of numerical comparison. The specimens were subjected to a standard permeability test. They were also tested as beams with a central knife edge load from which the ultimate extreme fibre stresses in bending were obtained. These results were plotted as shown in Fig. 9. The results of tests on 200 samples of clay confirmed that a particular bed of clay near Jinja was the most satisfactory site. This site is 4 miles from the Owen Falls dam, 1 mile from the main railway line, and has direct water routes across Lake Victoria to the shores of Uganda, Kenya and Tanganyika.

Because it was found in the laboratory that admixtures would be required to the clay to enable it to be passed through the kiln rapidly, a complete layout of clay working machinery was ordered to include a grinder, screens, mixer, and de-airing auger. The layout of the machinery, together with the remainder of the factory is shown in the upper part of Fig. 8. The photographs reproduced in Figs. 1—6 give a further impression of the factory and plant.

Kiln

The electric tunnel kiln was supplied by The General Electric Company, Ltd., and erected by the Public Works Department. It is a short kiln with an effective length of 100ft. A diagrammatic layout of the kiln is also shown in Fig. 8. Products are stacked directly on the refractory hearths of the wagons to a height of 36in above hearth level with a width of stack of 18in. No spacing pieces between wares were found to be necessary. Cellular blocks are stacked first for stability with roofing tiles placed on the tops of the stacks. The wagons are pushed through the kiln by an automatically controlled hydraulic ram. When a fresh wagon is pushed into the kiln all the wagons move along one space and a fired wagon is pushed out of the discharge end.

As shown in Fig. 8, the kiln can be divided into a preheating section, firing section and cooling section. Only the firing section contains resistors and is itself divided into three separate zones, each of which is connected to a separate control pyrometer. The nichrome resistors are 0·20in in diameter and are formed into coils having an outside diameter of $1\frac{1}{4}$in. These coils rest horizontally on refractory shelves in the walls of the firing section. Each zone has two phases and is supplied by its own three-phase/two-phase transformer with adjustable tappings. The three-phase sides of these transformers are connected to contactors operated by their separate control pyrometers. The two-phase sides of these transformers can be adjusted between 103V and 126V. Each of the three zones is rated at 100kW.

Laboratory Firing Tests

Tests were carried out on full-size products in a small controlled electric furnace to find the minimum permissible overall firing cycle which did not harm the products. The thermal properties of the clays during firing were examined

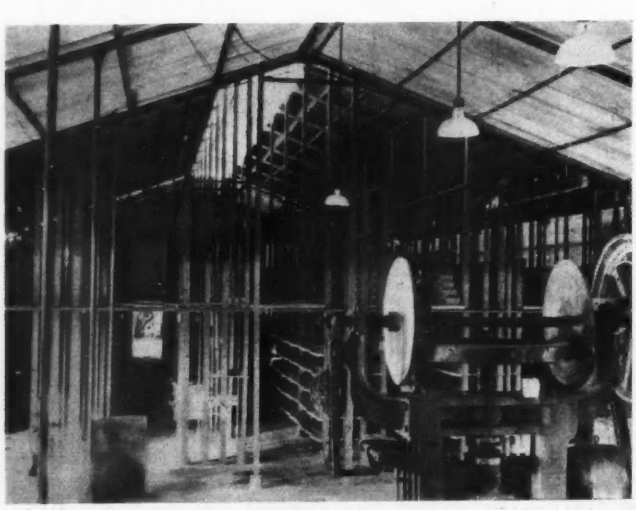


Fig. 6—Drying shed during construction, showing method of supporting pallettes on tensioned wire shelves

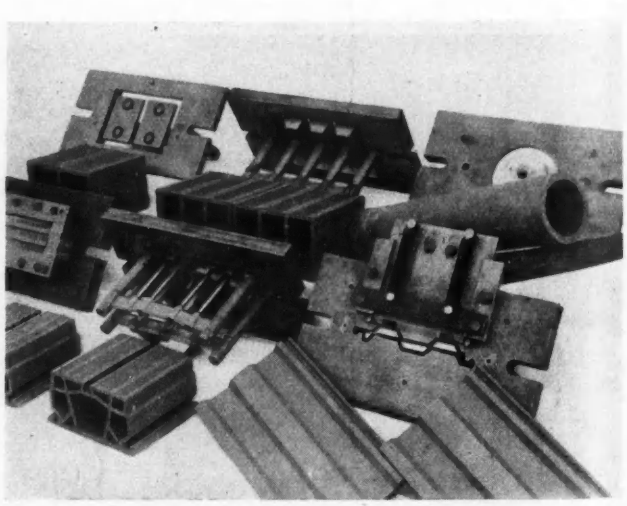


Fig. 7—Some extruded products, together with their dies

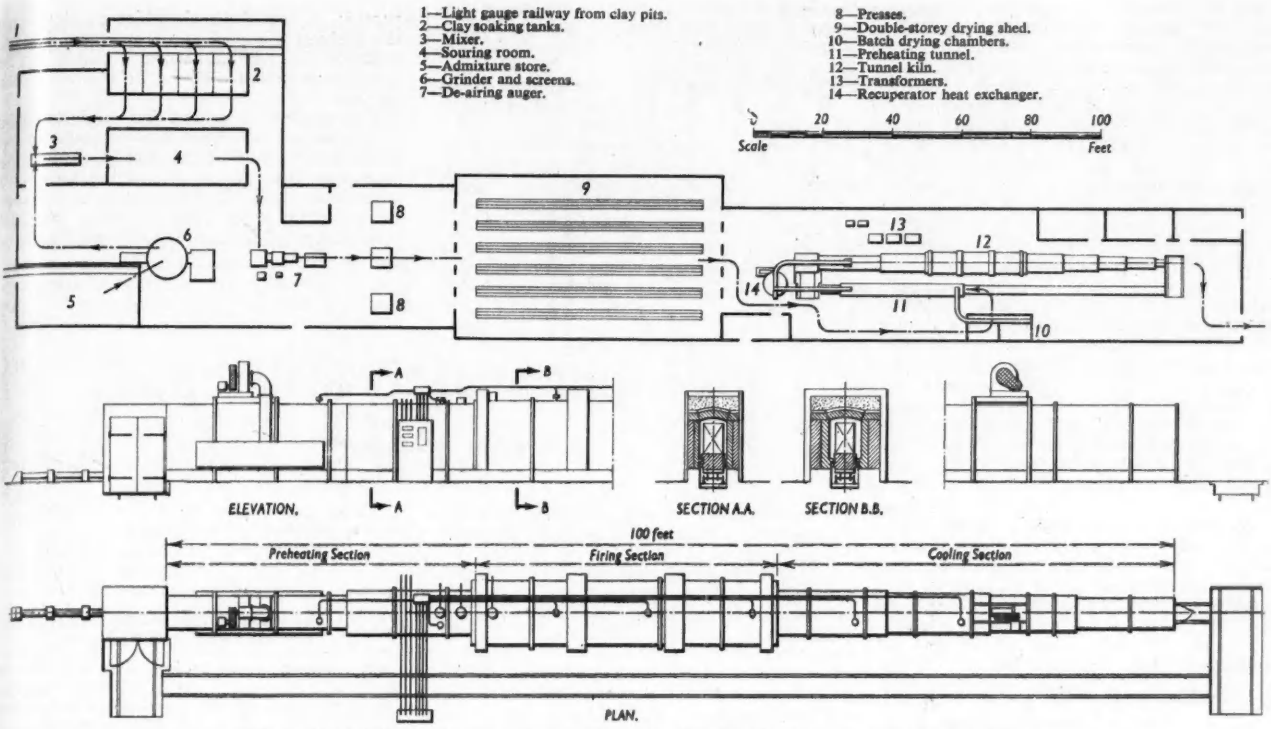


Fig. 8—General layout of clay products factory and diagrammatic layout of electric tunnel kiln

and the heat necessary to fire 1 lb of final product was found by calculation.

To assist in the better understanding of the heat transfer in the kiln and especially the various temperatures throughout the kiln the following simple empirical method was used by the author.

Preheating Section.—Using empirical heat transfer formulæ, the heat flow into the products at any point along the preheating section can be expressed thus :

$$\underset{\rightarrow p}{q} = 0{\cdot}163(t_a - t_p)\sum \frac{\underset{a\rightarrow p}{A} \cdot V_p^{0{\cdot}8}}{D_p^{0{\cdot}25}} + 0{\cdot}532 \underset{w\rightarrow p}{E} \cdot \underset{w\rightarrow p}{A}\left[\left(\frac{T_w}{100}\right)^4 - \left(\frac{T_p}{100}\right)^4\right] \quad . \quad (1)$$

Similarly the heat flow from the air in watts can be written

$$\underset{a\rightarrow}{q} = 0{\cdot}163(t_a - t_p)\sum \frac{\underset{a\rightarrow p}{A} \cdot V_p^{0{\cdot}8}}{D_p^{0{\cdot}25}} + 0{\cdot}163(t_a - t_w) \cdot \frac{\underset{a\rightarrow w}{A} \cdot V_w^{0{\cdot}8}}{D_w^{0{\cdot}25}} \quad . \quad . \quad . \quad . \quad (2)$$

Nomenclature

t_a—Mean temperature of air at any point along the kiln in degrees Centigrade.
t_p—Mean temperature of products at any point along the kiln in degrees Centigrade.
t_w—Mean temperature of walls at any point along the kiln in degrees Centigrade.
T_w—Mean temperature of walls at any point along the kiln in degrees Centigrade (absolute).
T_p—Mean temperature of products at any point along the kiln in degrees Centigrade (absolute).
$\underset{a\rightarrow p}{A}$—Areas of contact with air of products for convectional heat transfer calculations (square feet per foot length of kiln).
$\underset{w\rightarrow p}{A}$—Area for radiation heat transfer calculations (square feet per foot length of kiln).
$\underset{a\rightarrow w}{A}$—Area of contact with air of walls, roof and hearth for convectional heat transfer calculations (square feet per foot length of kiln).
V_p—Mean velocities of air between products themselves and between products and walls for convectional heat transfer calculations (normal feet per second).
V_w—Mean velocity of air flowing past walls for convectional heat transfer calculations (normal feet per second).
D_p—Representative diameter for convectional heat transfer calculations—spaces between products (feet).
D_w—Representative diameter for convectional heat transfer calculations—spaces between products and walls (feet).
$\underset{w\rightarrow p}{E}$—Emissivity (walls to products).
$\underset{\rightarrow p}{q}$—Heat flow into products in watts per foot length of kiln.
$\underset{a\rightarrow}{q}$—Heat flow from air in watts per foot length of kiln.
$\underset{w\rightarrow}{q}$—Heat flow through walls, roof and hearth in watts per foot length of kiln.

Note.—1W is equivalent to 1 joule per second or 3·413 B.Th.U.s per hour.

Assuming the heat losses from the external casing of the kiln to be proportional to temperature difference, the heat lost by conduction through the walls of the preheating section in watts can be presented as

$$\underset{w\rightarrow}{q} = k_1 t_w - k_2 \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where k_1 and k_2 are constants depending on the thermal conductivities of the wall components and the resistance to heat flow of internal surfaces and the kiln steel casing. But

$$\underset{a\rightarrow}{q} = \underset{\rightarrow p}{q} + \underset{w\rightarrow}{q} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Substituting equations (1), (2) and (3) in equation (4) a reasonable, approximate relationship can be established between t_p, t_a and t_w at any point along the length of the preheating section. Using equation (4), lines of equal values of t_w can be plotted as shown in Fig. 10.

The same formulæ were used for the cooling section with the necessary signs reversed. The firing section equations were derived similarly, but with the inclusion of heat flow from the resistors.

Fig. 10 represents calculations for a maximum temperature of products of 800 deg. Cent., a flow of products of 900 lb per hour and a counter-flow of air of 5·8 normal cubic feet per second. A position for point *B* was selected on the line $t_p = 800$ deg. Cent. Knowing the values of t_a and t_w at this point, it was possible to find the heat flow into products and air at this point. Using calorimetric calculations, the temperature changes of products and air at this point per foot length of kiln were obtained. Line *A* was plotted in this manner. The final position of point *B* was selected such that line *A* terminated at the known entrance temperatures of products and air. This method of plotting line *A* graphically was necessary because the heat required to raise the temperature of the clay products a specific increment of temperature varies throughout the preheating and initial firing stages due to the changing rate of loss of free water and water of chemical combination from the clay while its temperature is being raised.

The calculated heat losses obtained from Fig. 10 are expressed as percentages as follows :—

	Per cent
Heat lost through walls	20
Heat lost in exhaust air	60
Heat taken away by hot products leaving kiln	17
Heat taken away by hot wagon hearths leaving kiln ...	3
	100

These figures emphasise the importance of reducing the quantity and the temperature of exhaust air leaving the kiln to the minimum.

Fig. 11 shows temperature curves derived from Fig. 10. Clay was blended with admixtures of powdered burnt clay and finely ground sand to produce a material which was not damaged when its laboratory firing temperature curve was similar to the calculated temperature curve

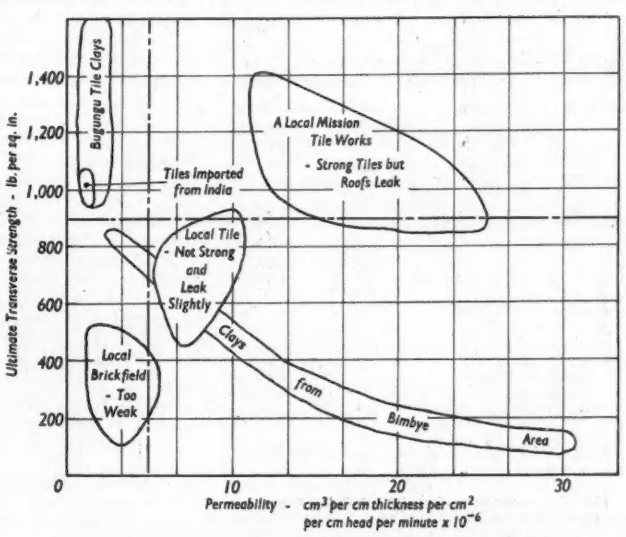
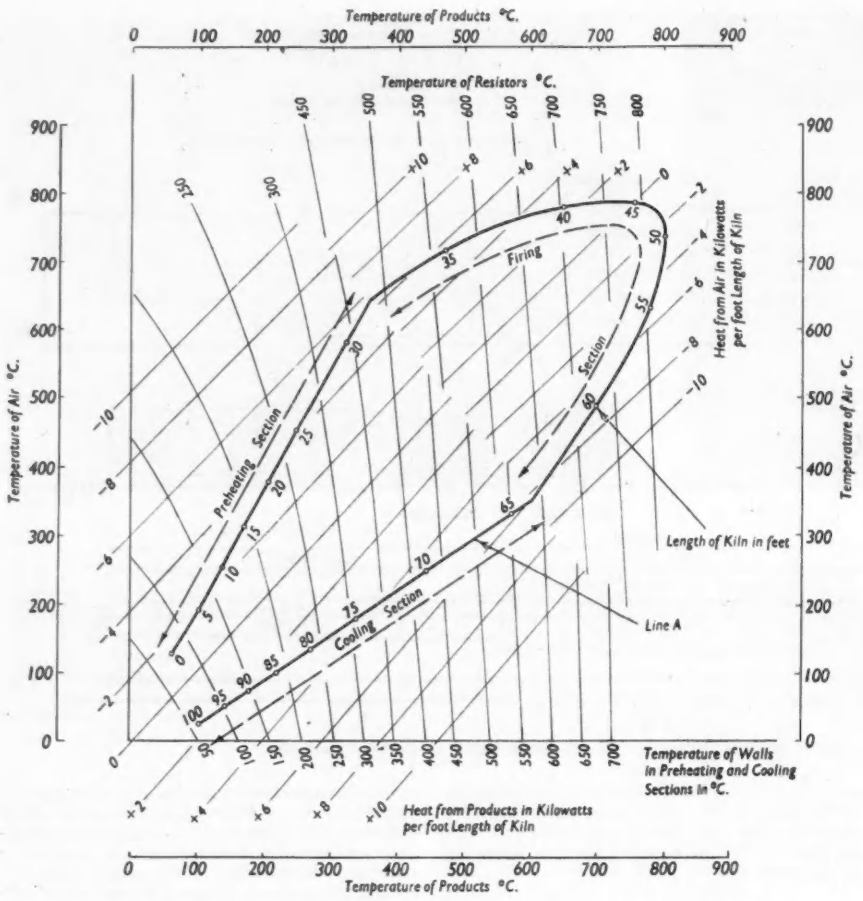


Fig. 9—Permeabilities and transverse strengths of some samples of fired clay tested


Temperature of Products °C.
Temperature of Resistors °C.
Temperature of Air °C.
Heat from Air in Kilowatts per foot Length of Kiln
Preheating Section
Firing Section
Cooling Section
Length of Kiln in feet
Line A
Temperature of Walls in Preheating and Cooling Sections in °C.
Heat from Products in Kilowatts per foot Length of Kiln

Length of kiln, 100ft ; maximum temperature of products, 800 deg. Cent.; flow of products, 900 lb per hour ; flow of air, 5·8 normal cubic feet per second.

Fig. 10—Heat transfer chart

shown in Fig. 11. No allowance was made in these calculations for additional heat required to dry artificially the products before placing them in the kiln. Trial production proved that an excess of air had to be passed through the kiln to provide additional heat for drying and preheating the products. Readings taken during trial production showed that this method of calculating the power consumption is adequate for the accuracy required in furnace calculations.

Trial Production

Firing tests in a laboratory furnace had shown that it was necessary to preheat the products before they could enter the tunnel kiln without cracking. Also especially during the rainy seasons artificial drying preceding this preheating would be necessary. Although normally the midday atmospheric conditions at Jinja are favourable to the efficient drying of clay, the humidity rises considerably at night and moisture returns to products which have reached the last stages of drying, cracking them. A recuperator type heat exchanger, preheating tunnel and batch drying chambers were designed by the Public Works Department and erected by them together with the tunnel kiln. The recuperator was included so that the flow of air in the tunnel kiln could be reduced to the minimum required for efficient firing, thus reducing the amount of heat taken away by the exhaust air. A trial test without the recuperator using the minimum quantity of air necessary for the efficient firing of the ware in the kiln proved that exhaust air taken straight from the kiln into the preheating tunnel contained excessive moisture which condensed on the products in the lower, cooler parts of the preheating tunnel and cracked the clay, causing stacks to collapse later when they were passing through the kiln. A flow diagram and detail of the recuperator are shown in Fig. 12. The wet air from the kiln is used in the recuperator to heat fresh air which is blown into the preheating tunnel and from there into the batch drying chambers, where it passes into the atmosphere before reaching its saturation temperature.

Trial production proved that products having a thickness of clay of less than ⅜in could be fired in the kiln with an overall time in the kiln, not including time in the preheating tunnel, of twenty-two hours with a percentage of breakages of less than 1 per cent. With a maximum temperature of product of 850 deg. Cent. the

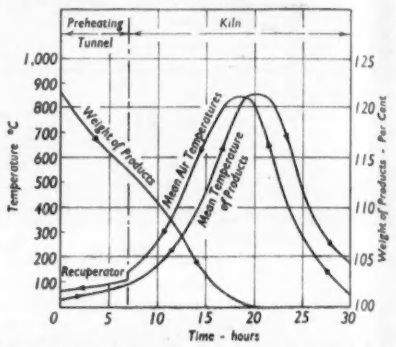


Fig. 13—Mean temperatures and moisture contents of products during trial production

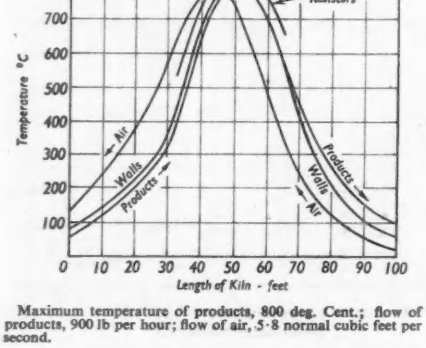
mean power consumption was 133kW, or 0·20kW per pound weight of fired product. These trials proved that the product with a large number of thin webs, ¼in thick, rather than the usual type of cellular clay product having a heavier cross section with a thickness of clay of ⅛in or more, is best suited to firing in this type of electric tunnel kiln. Mean temperatures and moisture contents of products during trial production are illustrated roughly in Fig. 13. The moisture content is represented by the weight of the product including its water content, the fired weight of the product being taken as 100 per cent.

Full Production

The problems of production are mainly economic, and the development of new kinds of products. All dies are made in the factory. More intricate extrusion dies which take advantage of the fine texture of the local clay and produce products having lighter cross sections with thin walls and webs are being made. These developments will include the manufacture of prestressed clay sections mainly for prefabricated roofs. From crushing tests on cellular clay products the ultimate compressive stress on clay walls acting as columns ¼in thick forming these prestressed sections can be taken as 6600 lb per square inch, which is in the region of that used for normal prestressed concrete design.

Production Costs

The present cost of electricity for this factory is based on a monthly kVA charge of 15s. per kVA plus 25 per cent surcharge and, in addition,



Maximum temperature of products, 800 deg. Cent.; flow of products, 900 lb per hour; flow of air, 5·8 normal cubic feet per second.

Fig. 11—Chart showing temperatures calculated using empirical formulæ

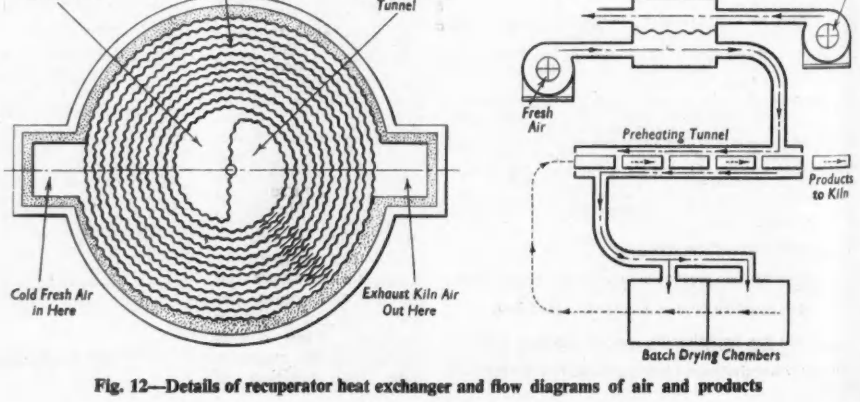

Aluminium Sheeting Effective Height 9'-9"
Exhaust Air from Kiln in Here
Hot Fresh Air Out Here to Preheating Tunnel
Cold Fresh Air in Here
Exhaust Kiln Air Out Here
Heat Exchanger
Exhaust Air from Kiln
Fresh Air
Preheating Tunnel
Products to Kiln
Batch Drying Chambers

Fig. 12—Details of recuperator heat exchanger and flow diagrams of air and products

0·10s. per kW plus 25 per cent surcharge. With this cost of electricity the operating expenses of the complete factory are estimated as follows :—

	Per cent
Electricity for kiln...	44
Overall cost of labour for factory	21
Depreciation of plant and buildings	16
Repairs and spare parts for machinery and kiln	8
Electricity for machinery	5
Transport and water supply	4
Miscellaneous	2
	100

Production so far has proven that a small electric tunnel kiln of this type can be used economically for the production of building products providing a clay of fine texture is found and is preheated before entering the kiln and providing designs of wares tend towards a product which is in fact a crude form of pottery of high strength. The uniformity of the wares enable lower factors of safety and therefore lighter designs to be considered.

The further reduction of the power consumption per unit weight of fired product will be attempted by lengthening the preheating tunnel, raising the maximum temperature slightly in the firing section to cope with increased production, and extending the cooling section of the kiln. The products will be pushed through the kiln at a greater speed and it is expected that the power consumption per unit weight of fired product will be reduced.

Economical Specifications for Concrete

WE have received from the Ministry of Works some details of an investigation which the Ministry's civil engineering staff has been carrying out over the past four years into nominal mix specifications for concrete. It was decided, at an early stage in the investigations, that the standard specifications were unsatisfactory : these usually called for a nominal mix, minimum cube strength and frequently a definite slump, irrespective of the characteristics of the aggregates which would have to be used in any particular case.* All the points in a specification could not always be fulfilled. It was therefore decided to adopt a specification giving the end product required—that is, the minimum strength of the concrete, and any other requirements such as freedom from surface defects, water tightness, &c., as might be required for each particular job—leaving the contractor in each case free to design the mix to suit the aggregates available.

Specifications of this kind were first introduced by the Ministry of Works in 1952, and since then over sixty contracts have been completed on which the concrete was specified in this manner. The results have been so successful, the Ministry states, that all contracts, in which there is any considerable quantity of concrete, now contain specifications of this kind. The Ministry's directorate of works maintains a small section which deals with questions of concrete quality and production and advises contractors, if so desired, on the proportions which can be used in any particular case. In general, the results show that the use of a "guaranteed strength" specification, mixes designed for workability and strength to suit the aggregates, and compaction by vibration, can lead to a reduction in costs and to a definite improvement in the uniform quality of the concrete.

Examples obtained by the Ministry of Works in actual practice show that the reduction in the proportions of cement used has varied from about 10 per cent in cases of hand-placed concrete designed for 3000 lb per square inch at twenty-eight days, to 40 per cent in a case of high-quality concrete for prestressed work. Reductions in cement content of 15 to 20 per cent are common when vibration is used to produce concrete of minimum 3000 lb per square inch compressive strength at twenty-eight days. Table I gives details of actual mixes used in a number of different contracts where the concrete was vibrated. To allow for variation in the materials and site supervision, the average cube strength requires to be higher than the specified minimum strength. The allowance is varied with the degree of control anticipated on each individual site. It is not always possible, the Ministry points out, to obtain results as striking as those shown in the table, but savings of 15 to 20 per cent of cement (¾ cwt to 1 cwt per cubic yard) are normal. As a rule, the characteristics of the coarse and fine aggregates available control the mix which can be used in any particular case.

Apart from the saving of cement the advantages claimed from these designed mixes are : a saving of a few shillings per cubic yard in cost of materials ; the production of concretes which are denser, less liable to frost damage and less liable to cracking and crazing due to shrinkage; and it is not uncommon for a properly designed mix to show better workability than a standard mix, even though it has a lower W/C ratio.

TABLE I—*Concrete Mixes on Various Ministry of Works Contracts*

Site	Code of Practice mix (by volume)	Specified minimum cube strength at 28 days, lb/sq in	Mix adopted			Average cube strength at 28 days, lb/sq in	Cement saving, cwt/cu yd
			Proportion by weight	Size of aggregate, inches	W/C ratio		
12	1 : 1 : 2	5500	1 : 1·74 : 4·87	1	0·45	6666	3·10
52	1 : 1 : 2	6000	1 : 1·5 : 3·8	¾	0·38	8384	2·31
6	1 : 1½ : 3	4000	1 : 2·25 : 5·78	1½	0·50	5086	1·79
7	1 : 1½ : 3	4000	1 : 2·04 : 5·01	1½	0·48	5285	1·31
21	1 : 1½ : 3	4000	1 : 2·0 : 6·0	1½	0·45	5691	1·79
1	1 : 2 : 4	3000	1 : 2·23 : 6·77	1½	0·54	4006	0·93
3	1 : 2 : 4	3000	1 : 2·45 : 6·52	1½	0·51	4607	0·93
30	1 : 2 : 4	3000	1 : 2·20 : 6·80	¾	0·56	4319	0·93

The full advantages of designed mixes are, of course, only obtained if vibration is used, but there are similar, though lesser, advantages in designing mixes for placing by hand. If a concrete is to be hand-compacted it is seldom necessary to use a mix richer than 7½ : 1 by weight in order to obtain a minimum cube strength of over 3000 lb per square inch at twenty-eight days. Mixes of this order will show cement savings of up to ½ cwt per cubic yard. Provided a concrete of reasonable quality is needed (that is, a concrete with a water-cement ratio below 0·6) it will, however, usually be found cheaper to use internal vibration. A good type of internal vibrator can consolidate thoroughly over 5 cubic yards per hour if the concrete is properly designed. At the same time, if internal vibration is used it has been found possible and economical to use 1½in aggregates for work on which this type of aggregate would not be permitted by the Code of Practice (e.g. where the cover is less than 1¾in), without any tendency to honey-combing or defective surfaces.

In the course of the work outlined above, a number of interesting techniques have been investigated which promise material reductions in cost if the work is organised properly. They include the use of a power float for surface finishing ; of a vibrating roller for consolidating thin concrete slabs, next to the ground, and of striking shutters while the concrete is still green.

The power float, it was found, permitted the use of a lower water-cement ratio and fewer fines than are used with normal hand placing, when casting granolithic paving, which gave less laitance to cause dusting. The machine also produced considerable consolidation, resulting in a harder and more durable surface ; furthermore, it is pointed out, the process is faster, and the machine will comfortably do as much work as eight plasterers in a given time. Where the concrete of the base slab has been vibrated, a further development has been to lay the granolithic surface when the base slag is "green," in which case the pressure of the machine knits the granolithic topping with the base concrete and the thickness of the former can be reduced to a nominal ¼in or ¾in. In the Ministry's experience, the two layers have been found to be fully monolithic, and the granolithic surfacing can be considered as part of the structural member and the total thickness reduced by this amount.

Later work has shown that the power float can be used for producing a finished surface on any ordinary concrete slab and it has in fact been employed to finish off concrete of which the aggregate was 1½in down and the aggregate cement ratio 9 to 1.

The poker vibrator is not suitable for the consolidation of thin concrete slabs and so a search was made for more satisfactory methods. The vibrating roller has been found satisfactory as a means of consolidating slabs made in contact with the ground, up to 8in thick, and over a wide range of mixes provided that the concrete mix is properly designed. Full consolidation throughout the thickness of the slab has been obtained, it is stated, with lean, dry concrete of an aggregate cement ratio of 16 : 1, and the crushing strength of 6in cubes cut from this slab was over 2000 lb per square inch at twenty-eight days. With richer mixes (A/C ratio of the order of 8 : 1) core strengths of over 5000 lb per square inch at twenty-eight days have been obtained regularly, so that in cases where the strength of concrete is the determining factor, it has been found possible to reduce slab thicknesses. Slabs normally designed 6in thick have been reduced to 5in., and where the power float has been used in conjunction with the roller, slabs originally 6in thick, including a granolithic topping are now made 5in thick, including the minimum ¼in granolithic surface.

Using a properly designed vibrated concrete it has been found possible to strip shutters about two hours after placing. It is possible to strip much earlier than this, but because of the liability to casual damage it is not considered desirable. Provided the shutters have been suitably designed, the Ministry states, any shuttering can be stripped at this stage unless there is a pronounced overhang. With early striking, the exposed surfaces can be prepared for early treatment while green. If a smooth finish is required it is only necessary to rub down with a wooden or steel float, when a surface equal to a rendered surface can be obtained. If a plastered finish is required for any reason (e.g. acoustic properties) the surface can be washed off with a fine spray of water, giving a key for the plaster without any hacking. It is also possible to wash off the surface to leave an effective finish by exposing the aggregate. Joints can be washed off with a fine spray of water, leaving the aggregate fully exposed to provide a good face against which to place further concrete. If the work is such that the shutters can be used repeatedly, the amount of shuttering required for the whole job is considerably reduced. One case is known of a contractor who has consistently cast two columns 10ft high each day from each of his forms.

* In "Concrete Aggregates from Natural Sources," published in *Building Materials Digest* for October, 1954, it is stated : "Formerly there was a tendency to demand aggregates of gradings to suit a predetermined mix design ; now there is a movement towards a more practical course of adapting the mix design to suit locally available materials, the resulting concrete being of the same strength."

TENTH CONGRESS OF UNIPEDE.—L'Union Internationale des Producteurs et Distributeurs d'Energie Electrique is to hold its tenth congress in London from September 19 to 23, 1955, under the presidency of Lord Citrine, chairman of the British Electricity Authority. Some 400 delegates are expected at the sessions, which are to be held at Church House, Westminster. There will also be a number of study tours to places in England, Wales and Scotland. Unipede was founded in 1925 and has its permanent seat in Paris. It is an association of national organisations which primarily represent the interests in each country of producers and distributors of electricity. Its tasks include economic and engineering problems of electricity supply, international electricity transfers and the compilation of statistics.

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THE GOVERNMENT'S INTENTIONS

The Speech from the Throne which opens a new Session of Parliament indicates what a Government proposes to do. But what it actually does in the ensuing months may, of course, be quite different! Thus, though in the Queen's Speech last week a number of subjects of interest to engineers were touched upon, only the future will show what the effects upon engineers may be. Confidence upon the outcome can only be expressed where the Speech refers to the continuance of a policy that has already been successfully followed for many years. For example, the words in the Speech which read "My Ministers will promote the development of the Colonial Empire and for this purpose will prolong the Colonial Development and Welfare Acts. . . . They will also continue to give full support to the Colombo Plan," should be construed to mean such a continuance of policy. The interest of those remarks for engineers lies in the fact that under those Acts £140 million has been provided for Colonial development during a ten-year period ending 1956, of which £90 million has already been spent; and that, as a consequence of the stimulation so provided expenditure on colonial development is now running at about £110 million a year. A proportion of that expenditure returns to this country in the form of payments for engineering supplies. Expenditure upon colonial development and under the Colombo Plan is, of course, nowadays undertaken primarily for humanitarian reasons in the attempt to relieve want amongst populations still rapidly expanding. But it is also true that to help undeveloped countries to develop themselves is also to maintain demand in this country for engineering products. At first those products will be principally of interest to a limited number of firms making such things as hydraulic plant and machinery, contractors' plant, road making machinery, rails and locomotives, harbour equipment and the like. But, looking further into the future, increased demand can eventually be expected for goods of a different character, like wireless sets and motor cars. Thus, upon a material basis of self-interest the Government's intentions in this field can be welcomed.

It is also very gratifying to learn that the Government has "decided to embark upon an expanded programme of road construction and improvement, designed both to increase safety on the roads and to promote the freer flow of traffic." There were even given in the debate following upon the Speech some more precise figures. Expenditure upon major road improvements and new construction is to run, according to Sir Anthony Eden, at "as much as two or three times the amount allowed by the present programme," the maximum figure for which is some £14,000,000 to £15,000,000 a year. It is certainly very questionable whether that rate of expenditure will prove nearly sufficient. For at best—and Governments seem usually pleased to attain a minimum rather than to feel any prick of conscience for not attaining the maximum—£45,000,000 a year can hardly give this country the roads it needs under a term of twenty years or so. It may be, indeed, so rapidly is road traffic expanding, that new construction and improvement under this plan will do little more than prevent road conditions becoming worse. Certainly the rate of expenditure envisaged does not suggest that many of the more expensive remedies proposed again and again in such reports as the Bressey plan, and the County of London plan, and many others before them, for the relief of traffic congestion in London, not to speak of other cities with equally pressing problems, can be adopted. For fifty years and more Governments have shied away from authorising expenditure upon plans that might really relieve congestion in cities and have instead adopted restrictive expedients. But unless indeed that radically restrictive expedient of banning all private cars from London's streets, first suggested before the war and recently revived, is to be adopted—for ourselves we believe it to be entirely impracticable—then within a very few years' time heavy expenditure to increase parking space, to widen narrower streets and to improve road junctions must become essential. Road engineers have been too often disappointed in the past to become excited now merely by a statement of Government intentions. They will not now lay themselves open to "frustrate hope severer than despair"; nor will they excite themselves unduly at the prospect of a Road Traffic Bill which, amongst other things, provides "power for experiments to be made with new techniques." They will prefer, like Asquith, "to wait and see."

Again it is admirable that the Government should express its will to "stimulate the expansion of facilities for higher technological education, so that advances in scientific research may be matched by increased industrial efficiency and production." But that sentence does not appear to foreshadow the taking of any action not already announced by the Government. The situation was elucidated by Lord Salisbury in the House of Lords last Tuesday. Plans provide for "a massive expansion" of the Imperial College in South Kensington, for major developments at Glasgow, Manchester, Leeds and Birmingham and lesser developments at Cambridge and Sheffield and other localities. In short the Government is concentrating attention "on Institutions already receiving Treasury grants." It is "linking the technological development as closely as possible with existing university institutions." Projects for selecting a small number of existing technical colleges and elevating them to the rank of special technological colleges appear to have been dropped. Those projects and others for making more use of the technical colleges seem, indeed, to have been bogged down by political considerations. Moreover a recent downward trend in the numbers of students offering themselves for technological education suggests that too rapid an expansion of resources might be wasteful, however great is the need of industry for technologically trained men. The attack needs to be transferred to the schools, to convince masters that the technological side of industry provides interesting and profitable careers for young men and high possibilities of advancement. There the Institution of Mechanical Engineers performed an excellent service last Tuesday by holding a conference on "Mechanical Engineering as a Profession" which was attended by many masters of schools and at which the need of industry for boys and young men of the highest intellectual attainments was stressed.

OF CUES—AND CRAFTS—AND CRICKET BATS—OF ALGEBRA—AND ART

So a tubular metallic billiards cue has now been made. How the influence of engineering skill is entering into sport! Yet why should it not? Indeed, the news that Accles and Pollock, Ltd., already a maker of bows, golf clubs and fishing rods, has now produced an aluminium cue prompts us to remark how interesting and how surprisingly complex the technical factors involved in the design of sports gear can prove to be, not to mention

the techniques of fabrication. No doubt conventional designs have been evolved over a long term of years by trial and error. But in building such an object as a cue out of new materials calculation and theory have a part to play. It has been found, for example, that the elastic recovery rate of the cue, subsequent to the blow received upon contact with the ball, and the degree of stiffness against lateral movement near the tip, both have an important influence upon its performance. Both, too, have obvious implications upon design in a new material. Moreover, the human frame requires of cues, as of other sports goods, complex qualities, ill-defined by such words as " balance " and " power." The technical problem of producing a metallic cue had to be solved in terms of the physical characteristics of the metal—a work hardening aluminium alloy has been chosen—the wall thickness of the tube, the rate of taper, the placing of rubber inserts at particular places to damp vibrations, and the positioning of the balance weight, a tubular steel liner, not as might be expected at the butt end, but about the vibration antinode of the cue. It is interesting to find that a good action has been obtained by keeping the wall thickness of the tube more or less constant at 0·056in over the whole length but varying the rate of taper of the tube from 0·0143inch per inch at the butt to 0·0075inch per inch at the tip, a solution to the problem that is probably not unique, but which may have been dictated by manufacturing methods.

Similar technical problems turn up whenever sports gear is designed. We hope we shall not be accused of giving too much prominence to the firm already mentioned if we refer as an example to fishing rods. Our editor happens to take a particular interest in them ! He holds that the mechanics of the fishing rod would well repay study by any engineers who happen also to be anglers. In use, for example, a fishing rod must be found free of any defined natural period of vibration ; it must have a certain amount of internal damping, neither too much nor too little ; it must have a remarkable elasticity ; and it must be capable of doing two very different jobs, those of casting a fly or a bait and of playing a fish. Moreover, to work out in theory what the skilled angler does with it in casting a fly or a spinning bait turns out to be so nice an exercise in dynamics that a kinship between anglers and golfers can be demonstrated ! Nor are there wanting intricate technical problems in the design of fishing reels, more particularly those known as " multipliers " used for casting out a spinning bait across the waters and its slow recovery beneath the surface. The inertia of the bobbin must be kept as low as practicable; its rate of revolution upon casting may momentarily reach or exceed 10,000 r.p.m. and the bearing pressures may attain, in playing a fish, several tons per square inch ! If mechanical braking is included in the design (to prevent the line overrunning on the outward cast) intricate calculations may be involved about the retarding forces acting on the bait as it flies through the air lifting out line behind it, calculations no doubt similar to those required for the design of rocket lifesaving gear. In other sports, as well, similar problems are found. More than once the action of a golf club during the swing has been revealed by multiple-flash photography showing how the golfer varies the force applied and how energy is stored in the shaft and released again as the ball is struck. But in other fields little has been done. What curious problems, we wonder, might be revealed if other sports implements, still made of traditional materials to traditional designs, were studied with the idea of constructing them of new materials. Has anyone thought, for instance, of a metallic cricket bat ? Or of metallic stumps ? But we must have a care ! " Heaven forbid ! " their Lordships of the M.C.C. may be tempted to exclaim with upraised hands, " Allow not the engineer to enter here ! "

Yet however carefully the intricate technical problems of designing sports goods are studied there comes at the end an imperative need to appeal to the human factor. The new cue could not have been successfully made without the help of Joe Davis ; in designing a metallic bat the services of Hutton would be needed ! For a man drives a spinning ball cleanly along the grass to the pavilion rails, or low over the tennis net to lift the chalk from the baseline, with implements that are not wholly scientific in design but which are fitted for the use of human muscles by peculiar artistic qualities, termed " balance," " power," " spring " or " stiffness." Those are not calculable qualities ; somehow the psychology of man enters into them ; however much else may be calculable, they can be derived only by trial and error. Men talk to-day about the advent of " automatic factories." But machines and mathematics, feed-back controls and electronic brains—thank God !—will never wholly be able to match the magic of human acquired skill, that astonishing ability of human brain and muscle, when given tools suited to eye and hand, to solve with ease and without apparent conscious effort technical problems that would utterly defeat a designer's algebra. Always and for ever, at play or at work, the world will need the craftsmen.

Literature

The English Windmill. By REX WAILES. London : Routledge and Kegan Paul, Ltd., 68–74, Carter Lane, E.C.4. Price 35s.

FOR many years there has been a need for a really comprehensive book on the history and construction of English windmills, at the same time paying tribute to the generations of skilled millwrights who built them, and to the hardy race of millers who worked them and often repaired them too. Bennett and Elton's *History of Cornmilling*, published over fifty years ago and so frequently quoted, is long out of date. More recent windmill literature has usually consisted of books, papers or articles dealing with mills selected by counties or even arbitrarily, or with a single mill, or with windmills and watermills mixed in one volume, the illustrations, apart from photographs, being sometimes more artistic than accurate. Mr. Wailes has now written an authoritative volume which successfully fills this need. His first book on *Windmills in England*, reviewed in THE ENGINEER of November 26, 1948, might be regarded as a preface to this one. His new volume is not likely to be surpassed and is, in fact, only just in time, for he records that there are only a score of windmills now working in England compared with fifty in 1946 and about 350 in 1919.

The author, who for over thirty years has been steadfastly recording and carrying out researches on windmills in England and Wales and, whenever opportunity offered, in the U.S.A., the Netherlands, France, Spain and Germany, is particularly well qualified for this task, to which he applies so much energy and enthusiasm, because he served his apprenticeship with a well-known firm of mechanical engineers in Lincoln, the centre of a county famous for its imposing tower mills and where his interest in them was first aroused. He is a member of the Institution of Mechanical Engineers, having served on its council ; a Fellow of the Society of Antiquaries ; is head of the family engineering business in London, and yet finds time during week-ends and holidays to travel widely as technical adviser to the Windmill Section, since its formation twenty-three years ago, of the Society for the Protection of Ancient Buildings, founded in 1877. It is appropriate that this book should appear now during his term of office as president of the Newcomen Society for the study of the history of engineering and technology, for he has been a loyal contributor to its *Transactions* for many years.

This volume, which is well produced and almost free from misprints, comprises three parts : (1) the mills, (2) the machinery, and (3) the men. In the first part, the author devotes separate chapters to each of the four important types, viz.: (i) the post mill, the oldest type and in which the rectangular weather-boarded buck or body was originally turned to face the wind by a tail-pole ; (ii) the smock mill, with its weather-boarded tower, usually octagonal, tapering upwards to its rotatable cap ; (iii) the tower mill, staunchly built of stone or brick and thus more likely to withstand storm or fire, and (iv) the drainage mill, with its scoop wheel. Mr. Wailes vividly describes the working and construction of four outstanding examples, of which he has made a special study, viz.: (*a*) Saxtead Green Mill, the best of the East Suffolk post mills ; (*b*) Union Mill, Cranbrook, Kent, the finest smock mill in England; (*c*) Trader Mill, Sibsey, Lincolnshire, a magnificent four-sailed tower mill still working to-day, and (*d*) Ashtree Farm Mill, on the River Bure, the last of the Norfolk drainage mills to work by wind till disabled by a storm in 1953. In the succeeding chapters, he discusses with a wealth of detail based on his wide experience the characteristics of each of these types, their traditions and their variations in different counties. The last chapter of Part I covers various minor, but nevertheless interesting, types, such as composite mills, hollow-post mills, horizontal mills and combined wind and water mills.

In Part II the eight chapters deal in considerable detail with the design and construction of the most important working parts of windmills, such as the several types of sails or sweeps, the fantail, cap, windshaft, brake wheel, the final drive, stones, sack-hoist, bolters for dressing flour, and other machines. Various industrial uses to which windmills have been put, besides the best known grinding of corn and raising of water, are mentioned.

The six chapters in the third part will, perhaps, appeal most to the non-technical reader as the author writes in an authentic, yet entertaining, way about millers of the past and also those he has known personally during the last thirty years. The book is

appropriately dedicated to his friend John Russell, the miller of Cranbrook, whose portrait is included. He also pays generous tribute to the ingenious millwrights, many of whose names are unrecorded, but whose sound workmanship stood for generations, and others who, in due course, became famous engineers—for example, John Smeaton (1724–1792), to whom the Royal Society in 1759 awarded its highest honour, the Copley Medal, for his outstanding achievements in mill-work, and William Cubitt (1785–1861), who, starting as a miller, worked as a millwright till 1812, and was eventually knighted for his engineering accomplishments. As the author so rightly stresses, the work of the millwrights in the mills is a fundamental part of the history of mechanical engineering.

When writing on the origins of windmills and on milling customs, Mr. Wailes ranges over seven and a half centuries, from the year 1191, with its first acceptable reference to a windmill in England, built at Bury St. Edmunds, to the present day, mentioning over 300 mills. These include (*a*) the oldest working windmill in England, built in 1665 at Outwood, Surrey, and maintained with generous financial aid from the Society for the Protection of Ancient Buildings, the Surrey County Council, the Friendship-in-Repair Fund of America and the New York Community Trust ; (*b*) the last cornmill built in England, viz., the eight-sailed tower mill erected in 1892 at Much Hadham, Herts, by Saundersons, well-known millwrights of Louth, and dismantled in 1910. The author also puts forward an interesting new theory of the origin of the windmill considered from the mechanical standpoint. The final chapter deals with the inevitable, but nevertheless regrettable, decline of windmills in this country, the urgent need both for more recording, with advice on how to do it, and for the preservation, before it is too late, of some carefully selected examples on site for the benefit of future generations. The decline has been due to many causes such as the import of foreign grain processed in large roller mills at the ports, the growth of towns, rail and motor transport, lack of labour and apprentices, restrictions in two world wars and high costs, which prohibit major repairs. The miller, whose words were recorded by Richard Jefferies seventy-five years ago, summed up the situation precisely when he said : " Our time be a-most gone by. . . . It be that there steam as have done for us."

This book contains several appendices, including one on the annular sail by Dr. F. C. Johansen, and another on stone dressing by John Russell ; an extensive glossary of milling terms; a bibliography; two maps showing the windmills mentioned in the text, and giving an indication of their distribution; lists by counties of over 300 windmills; and a good index. A particularly valuable feature is the wealth of illustrations comprising many accurate pen and ink drawings made by Vincent Lines, R.W.S., seventy-two photographs taken by the author, by Hallam Ashley, F.R.P.S., and others, and reproductions of paintings in the author's collection. These illustrations include all the windmills in England at present worked by wind and at least one from each county where windmills have worked during the last thirty years. A feature, which should appeal particularly to engineers, is the inclusion of nine isometric drawings showing clearly the internal construction and drives of mills with the parts numbered and named.

It is earnestly to be hoped that this new volume, which is a pleasure to read and to keep for reference, will encourage more engineers to take a keener interest in the early history of their profession and inspire all lovers of the countryside with increasing " zeal in the preservation of these beautiful structures."

Gears. By H. E. MERRITT. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, W.C.2. Price 60s.

THE first edition of *Gears* provided in one volume an ordered collection of its author's research and long experience in gearing. This third edition has been almost entirely rewritten and enlarged. It deals with all kinds of gears and covers the subject in a simple and practical manner readily understandable to the student or engineer. Those sections which require the use of mathematics are dealt with by geometric concepts plus a little trigonometry, the author having long since disposed of the idea that a good work must make difficult reading. A useful feature of the book is the well-ordered arrangement of a not easily classifiable subject matter which makes it simple to use either as a work of reference, or for a more prolonged study of the subject.

Dr. Merritt was originally largely responsible for the inception and general layout of the British Standard gear specifications, and in the first edition of *Gears* he included a comprehensive background to the methods leading up to the recommendations given in the specifications. A major alteration in the third edition is that the author has now drawn on his later experiences to suggest improvements on his earlier methods, and the subject of gear rating is brought right up to the state of existing knowledge.

The book contains all that is required to be known about the principles and analysis of tooth contact, the geometry of all kinds of gears and methods of design and detail dimensioning ; also some very practical chapters on subjects such as gear failures, gear lubrication, gear materials, accuracy and tolerances, gear trains (including change gear calculations) and a simple treatment of epicyclic gears. Numerous time-saving tables are included.

In the past, much has been written about gears in the form of specialised articles and papers, and the student tends to be bewildered at the outset by the mass of loose literature on the subject. *Gears* is largely the outcome of Dr. Merritt's originality, but he has never hesitated to take account of any significant findings by other workers in the same field, so that we now have in one volume what is probably the most complete and readable study of the subject yet written.

Resins in Industry

DURING this week an exhibition designed to demonstrate the multiplicity of industrial applications of " Epikote " resins has been staged at the Criterion, Lower Regent Street, London, by Shell Chemicals, Ltd. ; it closes to-morrow. A smaller edition of the exhibition will be on view in Birmingham, Manchester and Glasgow early in the new year. The resins are a new class of condensation polymer and represent an advance over the early synthetic resins. Their production has been made possible by the development of the " chemicals-from-petroleum " industry, together with intensive research. " Epikote " resins, produced synthetically from epichlorhydrin and diphenylolpropane and known as epoxy resins, impart their four main properties of toughness, flexibility, adhesion and resistance to chemicals and solvents, to formulations of which they form the base. To date, the main outlet for the resins is in surface coatings but the exhibition set out to demonstrate the many industrial applications, while one section included laboratory tests designed to demonstrate the various properties of the material. Numerous photographs and exhibits showed the use of the resins in the surface coatings industry, for which there are four main methods to produce air drying and stoving finishes. The corrosion protection afforded to structures and the internal steelwork and fittings of oil tankers were of particular interest. A number of domestic appliances illustrated the successful use of " Epikote " based stoving finishes which call upon all four qualities of the material. Sections of flooring demonstrated the wear-resistance of floor varnish and a sailing dinghy showed the water and abrasion resistance of " Epikote " based varnish, while a table served to illustrate the resistance to water, alcohol and heat. Many exhibits illustrated the possibilities of the resins in the plastics field, particularly for casting and laminating materials, and there were several examples of casting applications such as the " potting " technique for the protection of electrical components and cast insulation equipment. The value of the qualities of flexibility, adhesion and chemical resistance imparted to coatings based on " Epikote " formulations were shown in the section of the exhibition dealing with the internal coating of food containers and packaging.

Appointments to South of Scotland Electricity Board

ON December 1st, the Secretary of State for Scotland announced in Parliament the appointment of Mr J. S. Pickles and Sir Norman Duke to the posts of chairman and deputy chairman respectively of the new South of Scotland Electricity Board. Their designation for these positions had been announced to the House of Commons on July 29th. In addition, Mr. William Hutton and Mr. W. S. Sawtell have been appointed full-time members, and Colonel J. G. Crabbe, Sir John Imrie, Mr. Jackson Miller, Bailie John Sullivan and Sir Ronald J. Thomson have been appointed part-time members. The Board has been set up under the Electricity Reorganisation (Scotland) Act, 1954, and will take over from April 1, 1955, the functions of the present two Scottish Area Electricity Boards, for South-West Scotland and South-East Scotland, of which Mr. Pickles and Sir Norman Duke have been chairmen since these boards were constituted in January, 1948.

Books Received

Active Networks. By V. C. Rideout. London : Constable and Co., Ltd., 10, Orange Street, W.C.2. Price 42s.

Cost Accounting. By K. B. Mitchell. London : Iliffe and Sons, Ltd., Dorset House, Stamford Street, S.E.1. Price 10s. 6d.

Choosing Electric Cables. By C. C. Barnes. Manchester : Emmott and Co., Ltd., 31, King Street West, Manchester. Price 3s. 6d.

Graphics in Engineering and Science. By A. S. Levens. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 56s.

Production Tooling Equipment. By S. A. J. Parsons. London : Cleaver-Hume Press, Ltd., 31, Wrights' Lane, Kensington, W.8. Price 25s.

Engineering Metallurgy. By E. M. H. Lips. London : Cleaver-Hume Press, Ltd., 31, Wrights Lane, Kensington, W.8. Price 32s. 6d.

Journal of the Institute of Metals, 1952–53. Editor, N. B. Vaughan. London : Institute of Metals, 4, Grosvenor Gardens, S.W.1. Price 60s.

Some Fundamentals of Petroleum Geology. By G. D. Hobson. London : Oxford University Press, Ltd., Amen House, Warwick Square, E.C.4. Price 18s.

Heating in Industry. By G. A. Williams. Surrey : Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond. Price 3s.

Engineering Units and the Stroud Convention. For Students of Applied Mechanics and Engineering Science. Glasgow : Blackie and Son, Ltd., 17, Stanhope Street, C.4. Price 3s. 6d.

Ventilating in Industry. By G. A. Williams. Surrey : Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey. Price 3s.

Through Drying of Deep Beds of Wheat Grain

By Professor EWEN M'EWEN, M.Sc., M.I.Mech.E., and J. R. O'CALLAGHAN, M.Sc.

A method of analysis of the variables in drying beds of wheat is presented, which requires a minimum of experimentation in the design of a through-flow dryer, and is applicable to static or contra-flow operation. Experimental values of the design parameters are reported. It seems likely that this method of approach may be applicable to any material, in which the rate of drying in thin layers is not influenced by changes in the air rate.

Introduction

THE adoption of combine harvesting of grain requires some form of artificial drying of seeds as a complementary operation to reduce their moisture content to a safe value for storage. This problem has been broadly discussed in a paper by Woodforde (1953), and more recently, Simmonds, Ward and M'Ewen (1953), M'Ewen, Simmonds and Ward (1954), and O'Callaghan and M'Ewen (1954) have surveyed previous work and presented the results of their experimental drying of wheat grain on a laboratory scale.

The results of the investigations carried out in the Stephenson Engineering Laboratories, King's College, Newcastle upon Tyne, which are given in the references already cited, can be summarised by saying that for thin layers of grain the drying rate and time can be predicted from the equations :—

$$-\frac{\partial W}{\partial \theta} = 2{\cdot}3m(W_1 - W_e) \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$\theta_{12} = \frac{1}{m}\log_{10}\{(W_1 - W_e)/(W_2 - W_e)\} \quad . \quad (2)$$

where θ is the time in hours, m the rate constant, hr^{-1}, W_1 the moisture content at time θ, lb/lb, and W_e the equilibrium moisture content. The value of the rate constant for wheat is unaffected by air humidity and is a function of temperature only, given over the range 70 deg. to 170 deg. Fah. by* :

$$\log_{10} m = (t_a - 159)/87. \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where t_a is the air dry bulb temperature, deg. Fah. The equilibrium moisture content, W_e, is however, a function of air humidity primarily and to a lesser extent temperature ; there is also a small varietal effect. Representative values for design purposes can be obtained from Fig. 1, where the value of W_e at 100 deg. Fah. is plotted against relative humidity ; to correct to any other air dry bulb temperature, divide by the correction faction in Fig. 1*b*.

Drying of Deep Beds

The results obtained for thin layers enable a study to be made of the mechanism of wheat drying and enable the effects of the major variables to be studied. The practical dryer, however, requires consideration of a deeper bed.

Where the bed is of sufficient thickness for the air leaving it to be substantially saturated during the early part of the drying process, a fair approximation to the performance of the dryer may be obtained by calculating it as if it were a thin bed and using the rate constant corresponding to the logarithmic mean of the air dry bulb and wet bulb temperatures (Simmonds, Ward and M'Ewen, 1953b). This temperature is chosen because at the start of the decreasing rate period the grain in an adiabatic dryer is at or near its saturation temperature whilst towards the end of drying it approaches the air dry bulb temperature. This is admittedly a fairly rough rule, and in the case of thin layers does not lead to satisfactory results : Table I, opposite, illustrates the results obtained in practice.

It will be seen that the logarithmic mean temperature is above the effective mean temperature for thick beds or low rates of air flow ; for the thin beds at higher airflows the effective temperature approximates, as would be expected, to the air dry bulb temperature. In addition, the mean temperature approach gives no indication of the final moisture gradient in the bed.

An alternative semigraphical solution may

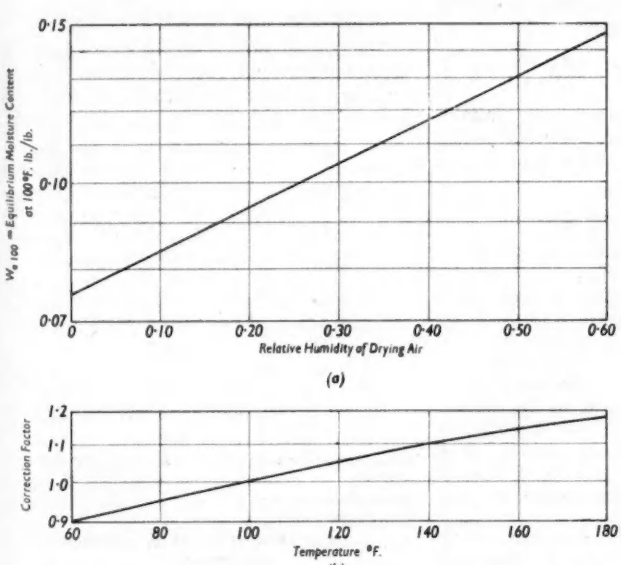


Fig. 1—(a) Effect of air humidity on equilibrium moisture content of wheat (b)—Temperature correction factors for equilibrium moisture content of wheat

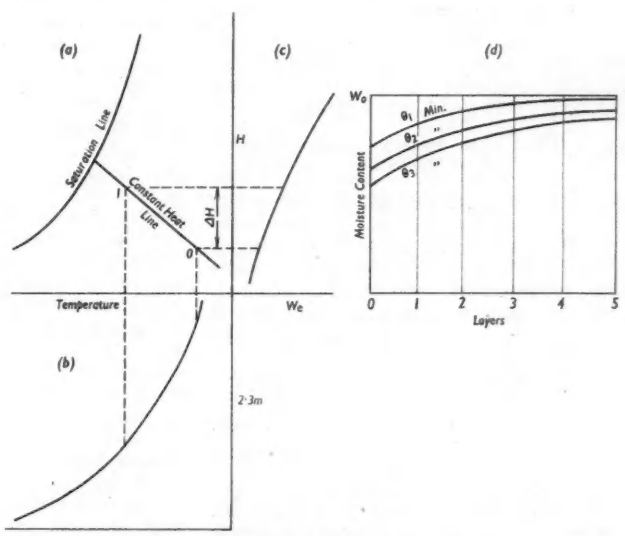
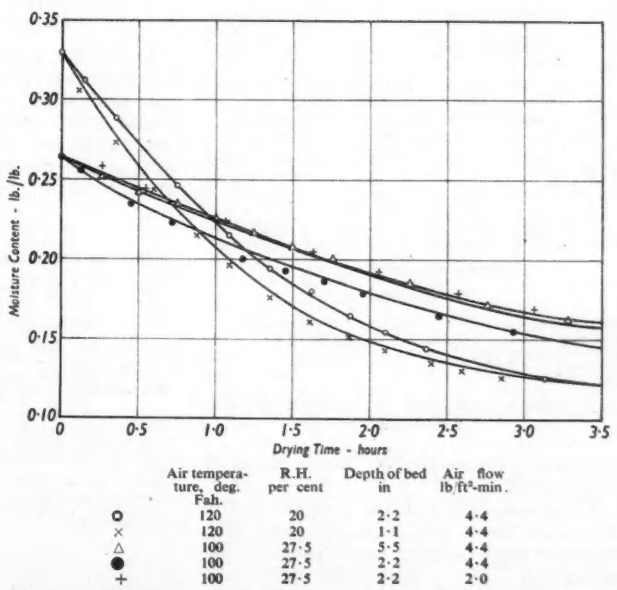


Fig. 2—Method of solution for deep beds of wheat



	Air temperature, deg. Fah.	R.H. per cent	Depth of bed in	Air flow lb/ft²-min.
○	120	20	2·2	4·4
×	120	20	1·1	4·4
△	100	27·5	5·5	4·4
●	100	27·5	2·2	4·4
+	100	27·5	2·2	2·0

Fig. 3—Agreement between actual and calculated drying curves for deep beds

Notation

G—Air velocity, pound dry air per square foot per minute.
H—Absolute air humidity, pound water per pound dry air.
m—Rate constant, hr^{-1} (in Fig. 2, min^{-1} is used for convenience).
t_a—Air dry bulb temperature, deg. Fah.
W—Moisture content of grain, pound water per pound dry grain.
z—Coefficient of performance.
θ—Time, hours.
Suffix *e*—Equilibrium conditions.
Suffix *1*—Conditions at inlet to a thick bed.

* Equation (3) is applicable to grain of normal size, approx. 0·13in diameter.

appropriately dedicated to his friend John Russell, the miller of Cranbrook, whose portrait is included. He also pays generous tribute to the ingenious millwrights, many of whose names are unrecorded, but whose sound workmanship stood for generations, and others who, in due course, became famous engineers—for example, John Smeaton (1724–1792), to whom the Royal Society in 1759 awarded its highest honour, the Copley Medal, for his outstanding achievements in mill-work, and William Cubitt (1785–1861), who, starting as a miller, worked as a millwright till 1812, and was eventually knighted for his engineering accomplishments. As the author so rightly stresses, the work of the millwrights in the mills is a fundamental part of the history of mechanical engineering.

When writing on the origins of windmills and on milling customs, Mr. Wailes ranges over seven and a half centuries, from the year 1191, with its first acceptable reference to a windmill in England, built at Bury St. Edmunds, to the present day, mentioning over 300 mills. These include (*a*) the oldest working windmill in England, built in 1665 at Outwood, Surrey, and maintained with generous financial aid from the Society for the Protection of Ancient Buildings, the Surrey County Council, the Friendship-in-Repair Fund of America and the New York Community Trust ; (*b*) the last cornmill built in England, viz., the eight-sailed tower mill erected in 1892 at Much Hadham, Herts, by Saundersons, well-known millwrights of Louth, and dismantled in 1910. The author also puts forward an interesting new theory of the origin of the windmill considered from the mechanical standpoint. The final chapter deals with the inevitable, but nevertheless regrettable, decline of windmills in this country, the urgent need both for more recording, with advice on how to do it, and for the preservation, before it is too late, of some carefully selected examples on site for the benefit of future generations. The decline has been due to many causes such as the import of foreign grain processed in large roller mills at the ports, the growth of towns, rail and motor transport, lack of labour and apprentices, restrictions in two world wars and high costs, which prohibit major repairs. The miller, whose words were recorded by Richard Jefferies seventy-five years ago, summed up the situation precisely when he said : " Our time be a-most gone by. . . . It be that there steam as have done for us."

This book contains several appendices, including one on the annular sail by Dr. F. C. Johansen, and another on stone dressing by John Russell ; an extensive glossary of milling terms; a bibliography; two maps showing the windmills mentioned in the text, and giving an indication of their distribution; lists by counties of over 300 windmills; and a good index. A particularly valuable feature is the wealth of illustrations comprising many accurate pen and ink drawings made by Vincent Lines, R.W.S., seventy-two photographs taken by the author, by Hallam Ashley, F.R.P.S., and others, and reproductions of paintings in the author's collection. These illustrations include all the windmills in England at present worked by wind and at least one from each county where windmills have worked during the last thirty years. A feature, which should appeal particularly to engineers, is the inclusion of nine isometric drawings showing clearly the internal construction and drives of mills with the parts numbered and named.

It is earnestly to be hoped that this new volume, which is a pleasure to read and to keep for reference, will encourage more engineers to take a keener interest in the early history of their profession and inspire all lovers of the countryside with increasing " zeal in the preservation of these beautiful structures."

Gears. By H. E. MERRITT. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, W.C.2. Price 60s.

THE first edition of *Gears* provided in one volume an ordered collection of its author's research and long experience in gearing. This third edition has been almost entirely rewritten and enlarged. It deals with all kinds of gears and covers the subject in a simple and practical manner readily understandable to the student or engineer. Those sections which require the use of mathematics are dealt with by geometric concepts plus a little trigonometry, the author having long since disposed of the idea that a good work must make difficult reading. A useful feature of the book is the well-ordered arrangement of a not easily classifiable subject matter which makes it simple to use either as a work of reference, or for a more prolonged study of the subject.

Dr. Merritt was originally largely responsible for the inception and general layout of the British Standard gear specifications, and in the first edition of *Gears* he included a comprehensive background to the methods leading up to the recommendations given in the specifications. A major alteration in the third edition is that the author has now drawn on his later experiences to suggest improvements on his earlier methods, and the subject of gear rating is brought right up to the state of existing knowledge.

The book contains all that is required to be known about the principles and analysis of tooth contact, the geometry of all kinds of gears and methods of design and detail dimensioning ; also some very practical chapters on subjects such as gear failures, gear lubrication, gear materials, accuracy and tolerances, gear trains (including change gear calculations) and a simple treatment of epicyclic gears. Numerous time-saving tables are included.

In the past, much has been written about gears in the form of specialised articles and papers, and the student tends to be bewildered at the outset by the mass of loose literature on the subject. *Gears* is largely the outcome of Dr. Merritt's originality, but he has never hesitated to take account of any significant findings by other workers in the same field, so that we now have in one volume what is probably the most complete and readable study of the subject yet written.

Resins in Industry

DURING this week an exhibition designed to demonstrate the multiplicity of industrial applications of " Epikote " resins has been staged at the Criterion, Lower Regent Street, London, by Shell Chemicals, Ltd. ; it closes to-morrow. A smaller edition of the exhibition will be on view in Birmingham, Manchester and Glasgow early in the new year. The resins are a new class of condensation polymer and represent an advance over the early synthetic resins. Their production has been made possible by the development of the " chemicals-from-petroleum " industry, together with intensive research. " Epikote " resins, produced synthetically from epichlorhydrin and diphenylolpropane and known as epoxy resins, impart their four main properties of toughness, flexibility, adhesion and resistance to chemicals and solvents, to formulations of which they form the base. To date, the main outlet for the resins is in surface coatings but the exhibition set out to demonstrate the many industrial applications, while one section included laboratory tests designed to demonstrate the various properties of the material. Numerous photographs and exhibits showed the use of the resins in the surface coatings industry, for which there are four main methods to produce air drying and stoving finishes. The corrosion protection afforded to structures and the internal steelwork and fittings of oil tankers were of particular interest. A number of domestic appliances illustrated the successful use of " Epikote " based stoving finishes which call upon all four qualities of the material. Sections of flooring demonstrated the wear-resistance of floor varnish and a sailing dinghy showed the water and abrasion resistance of " Epikote " based varnish, while a table served to illustrate the resistance to water, alcohol and heat. Many exhibits illustrated the possibilities of the resins in the plastics field, particularly for casting and laminating materials, and there were several examples of casting applications such as the " potting " technique for the protection of electrical components and cast insulation equipment. The value of the qualities of flexibility, adhesion and chemical resistance imparted to coatings based on " Epikote " formulations were shown in the section of the exhibition dealing with the internal coating of food containers and packaging.

Appointments to South of Scotland Electricity Board

ON December 1st, the Secretary of State for Scotland announced in Parliament the appointment of Mr J. S. Pickles and Sir Norman Duke to the posts of chairman and deputy chairman respectively of the new South of Scotland Electricity Board. Their designation for these positions had been announced to the House of Commons on July 29th. In addition, Mr. William Hutton and Mr. W. S. Sawtell have been appointed full-time members, and Colonel J. G. Crabbe, Sir John Imrie, Mr. Jackson Miller, Bailie John Sullivan and Sir Ronald J. Thomson have been appointed part-time members. The Board has been set up under the Electricity Reorganisation (Scotland) Act, 1954, and will take over from April 1, 1955, the functions of the present two Scottish Area Electricity Boards, for South-West Scotland and South-East Scotland, of which Mr. Pickles and Sir Norman Duke have been chairmen since these boards were constituted in January, 1948.

Books Received

Active Networks. By V. C. Rideout. London : Constable and Co., Ltd., 10, Orange Street, W.C.2. Price 42s.

Cost Accounting. By K. B. Mitchell. London : Iliffe and Sons, Ltd., Dorset House, Stamford Street, S.E.1. Price 10s. 6d.

Choosing Electric Cables. By C. C. Barnes. Manchester : Emmott and Co., Ltd., 31, King Street West, Manchester. Price 3s. 6d.

Graphics in Engineering and Science. By A. S. Levens. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 56s.

Production Tooling Equipment. By S. A. J. Parsons. London : Cleaver-Hume Press, Ltd., 31, Wrights' Lane, Kensington, W.8. Price 25s.

Engineering Metallurgy. By E. M. H. Lips. London : Cleaver-Hume Press, Ltd., 31, Wrights Lane, Kensington, W.8. Price 32s. 6d.

Journal of the Institute of Metals, 1952–53. Editor, N. B. Vaughan. London : Institute of Metals, 4, Grosvenor Gardens, S.W.1. Price 60s.

Some Fundamentals of Petroleum Geology. By G. D. Hobson. London : Oxford University Press, Ltd., Amen House, Warwick Square, E.C.4. Price 18s.

Heating in Industry. By G. A. Williams. Surrey : Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond. Price 3s.

Engineering Units and the Stroud Convention. For Students of Applied Mechanics and Engineering Science. Glasgow : Blackie and Son, Ltd., 17, Stanhope Street, C.4. Price 3s. 6d.

Ventilating in Industry. By G. A. Williams. Surrey : Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey. Price 3s.

Through Drying of Deep Beds of Wheat Grain

By Professor EWEN M'EWEN, M.Sc., M.I.Mech.E., and J. R. O'CALLAGHAN, M.Sc.

A method of analysis of the variables in drying beds of wheat is presented, which requires a minimum of experimentation in the design of a through-flow dryer, and is applicable to static or contra-flow operation. Experimental values of the design parameters are reported. It seems likely that this method of approach may be applicable to any material, in which the rate of drying in thin layers is not influenced by changes in the air rate.

Introduction

THE adoption of combine harvesting of grain requires some form of artificial drying of seeds as a complementary operation to reduce their moisture content to a safe value for storage. This problem has been broadly discussed in a paper by Woodforde (1953), and more recently, Simmonds, Ward and M'Ewen (1953), M'Ewen, Simmonds and Ward (1954), and O'Callaghan and M'Ewen (1954) have surveyed previous work and presented the results of their experimental drying of wheat grain on a laboratory scale.

The results of the investigations carried out in the Stephenson Engineering Laboratories, King's College, Newcastle upon Tyne, which are given in the references already cited, can be summarised by saying that for thin layers of grain the drying rate and time can be predicted from the equations :—

$$-\frac{\partial W}{\partial \theta} = 2 \cdot 3m(W_1 - W_e) \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$\theta_{12} = \frac{1}{m} \log_{10}\{(W_1 - W_e)/(W_2 - W_e)\} \quad . \quad (2)$$

where θ is the time in hours, m the rate constant, hr^{-1}, W_1 the moisture content at time θ, lb/lb, and W_e the equilibrium moisture content. The value of the rate constant for wheat is unaffected by air humidity and is a function of temperature only, given over the range 70 deg. to 170 deg. Fah. by* :

$$\log_{10} m = (t_a - 159)/87. \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where t_a is the air dry bulb temperature, deg. Fah. The equilibrium moisture content, W_e, is however, a function of air humidity primarily and to a lesser extent temperature ; there is also a small varietal effect. Representative values for design purposes can be obtained from Fig. 1, where the value of W_e at 100 deg. Fah. is plotted against relative humidity ; to correct to any other air dry bulb temperature, divide by the correction faction in Fig. 1*b*.

Drying of Deep Beds

The results obtained for thin layers enable a study to be made of the mechanism of wheat drying and enable the effects of the major variables to be studied. The practical dryer, however, requires consideration of a deeper bed.

Where the bed is of sufficient thickness for the air leaving it to be substantially saturated during the early part of the drying process, a fair approximation to the performance of the dryer may be obtained by calculating it as if it were a thin bed and using the rate constant corresponding to the logarithmic mean of the air dry bulb and wet bulb temperatures (Simmonds, Ward and M'Ewen, 1953b). This temperature is chosen because at the start of the decreasing rate period the grain in an adiabatic dryer is at or near its saturation temperature whilst towards the end of drying it approaches the air dry bulb temperature. This is admittedly a fairly rough rule, and in the case of thin layers does not lead to satisfactory results : Table I, opposite, illustrates the results obtained in practice.

It will be seen that the logarithmic mean temperature is above the effective mean temperature for thick beds or low rates of air flow ; for the thin beds at higher airflows the effective temperature approximates, as would be expected, to the air dry bulb temperature. In addition, the mean temperature approach gives no indication of the final moisture gradient in the bed.

An alternative semigraphical solution may

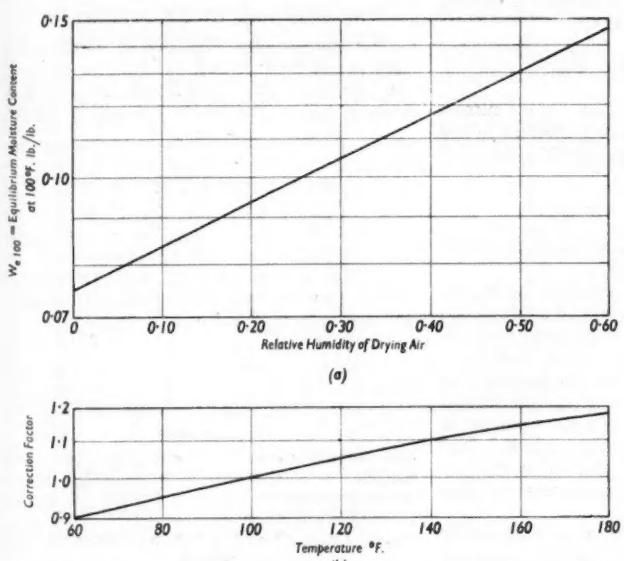


Fig. 1—(a) Effect of air humidity on equilibrium moisture content of wheat (b)—Temperature correction factors for equilibrium moisture content of wheat

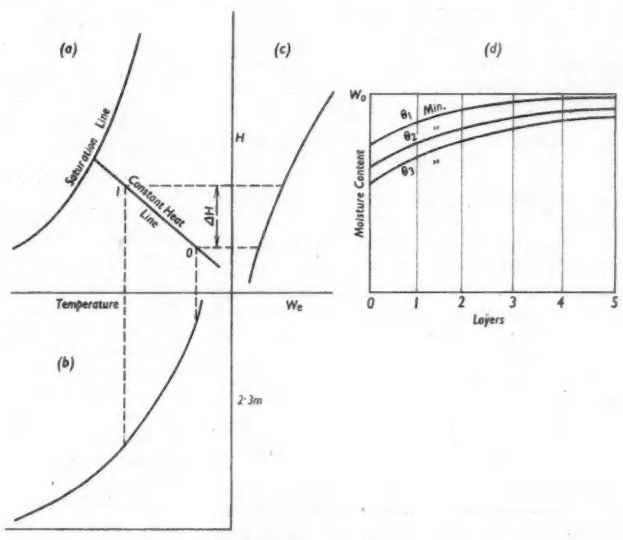
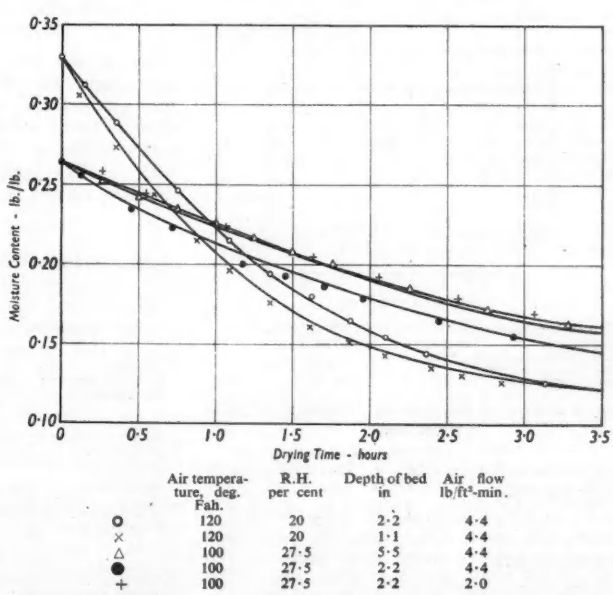


Fig. 2—Method of solution for deep beds of wheat



	Air temperature, deg. Fah.	R.H. per cent	Depth of bed in	Air flow lb/ft²-min.
○	120	20	2·2	4·4
×	120	20	1·1	4·4
△	100	27·5	5·5	4·4
●	100	27·5	2·2	4·4
+	100	27·5	2·2	2·0

Fig. 3—Agreement between actual and calculated drying curves for deep beds

Notation

G—Air velocity, pound dry air per square foot per minute.
H—Absolute air humidity, pound water per pound dry air.
m—Rate constant, hr^{-1} (in Fig. 2, min^{-1} is used for convenience).
t_a—Air dry bulb temperature, deg. Fah.
W—Moisture content of grain, pound water per pound dry grain.
z—Coefficient of performance.
θ—Time, hours.
Suffix *e*—Equilibrium conditions.
Suffix ,—Conditions at inlet to a thick bed.

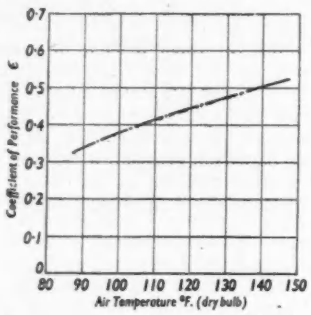
* Equation (3) is applicable to grain of normal size, approx. 0·13in diameter.

be obtained as follows :—

Assumptions

(*a*) A deep bed can be considered as a number of thin layers in series. In changing from a single layer to a deep bed the flow pattern is altered, but no serious error is introduced since it has been shown (Simmonds, Ward, and M'Ewen, 1953) that the rate of air flow does not affect the rate of drying in thin layers, unless the air rate is reduced to very low values.

(*b*) The total heat of the drying air remains constant. The heat taken up by the grain is negligible in comparison with the latent heat of vaporisation of the liberated moisture. As a result of this assumption, a constant heat line on a psychrometric chart is the locus of conditions through the bed at any instant.



Air humidity ... ... 0·0066 lb/lb
Mass flow... ... ... 3 lb/(ft²-min.)
Initial moisture content ... ... 0·275 lb/lb
Final moisture content ... ... 0·16 lb/lb
Depth of bed 6in

Fig. 4—Effect of air temperature on coefficient of dryer performance

(*c*) The drying rate in every layer remains constant during the time interval under consideration. By choosing time intervals in which the change in moisture content is small, errors are reduced and tend to be self-compensating.

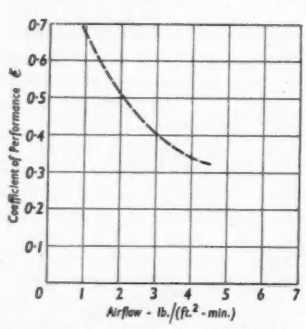
(*d*) The air is uniformly distributed across the bed.

(*e*) Heat losses from the dryer are neglected.

Method of Solution

Data Required.—Inlet air conditions : dry bulb temperature t_0, absolute humidity H_0, and weight of air per square foot per minute G.

Wheat : initial moisture content W_0 and



Air drybulb temperature ... ... 100 deg. Fah.
Humidity ... ... 0·0066 lb/lb
Initial moisture content ... ... 0·275 lb/lb
Final moisture content ... ... 0·16 lb/lb
Depth of bed 6in

Fig. 5—Effect of air flow on coefficient of dryer performance

correlations for m and W_e from thin layer experiments.

As shown on Fig. 2, on a psychrometric chart (*a*) plot the constant heat line corresponding to inlet conditions of the drying air. At (*b*) plot $2{\cdot}3m$ (min^{-1} for convenience), which is a function of the dry bulb temperature only. From corresponding values of temperature and relative humidity, as given by the intersection of the relative humidity and constant heat lines, determine the equilibrium moisture content W_e, which is plotted at (*c*). If a point can be located on the constant heat line, then values of m and W_e at that point are known. The deep bed is represented by a plot (*d*) of moisture content against an equivalent number of thin layers, where 0 is at the entrance and the last ordinate, in this case 5, the exit from the bed.

Consider an interval of time θ_1 minutes. At inlet to bed, at commencement of drying and under inlet air conditions,

$$-\frac{\partial W}{\partial \theta_1} = 2{\cdot}3\, m_0(W_0 - W_{e0})$$

Weight of water liberated per minute $= 2{\cdot}3\, m_0\beta(W_0 - W_{e0})$ where β = weight of dry stock in a layer; and increase in humidity of drying air

$$= \Delta H = 2{\cdot}3\, m_0\beta(W_0 - W_{e0})/G.$$

Decrease in moisture content of stock (in time θ_1) $= 2{\cdot}3 m_0\beta\theta_1(W_0 - W_{e0})$.

From the increase in absolute humidity, ΔH, of the drying air in passing through the first layer we can locate conditions at entry to the second layer (pt. 1, Fig. 2 (*d*)) and from Fig. 2 (*b*, *c*) read $2{\cdot}3m$ and W_e to calculate decrease in moisture content in the second layer. The decrease in each layer is plotted in (*d*) and joined by a smooth curve. The moisture content at the end of θ min. is directly proportional to the area under this curve.

This procedure is repeated at succeeding time intervals getting a plot of moisture distribution with time and position through the bed.

Experimental Verification of Semi-Graphical Solution

Using the results from the thin layers experiments on freshly harvested King II and the method of solution outlined above, drying curves were predicted for deep beds under different conditions and compared with results obtained by experiment under the same conditions. The agreement (typical results are shown on Fig. 3) was very satisfactory, suggesting that the proposed solution offers a reasonably accurate method of determining drying curves for deep beds from simple experiments on thin layers.

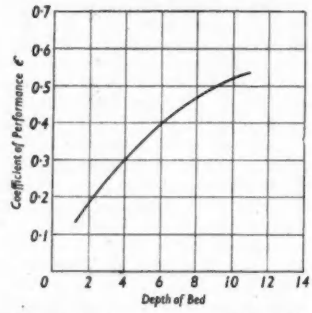
Examination of the method shows that the accuracy of the solution is not very susceptible to changes in the size of layer increment used, provided there are sufficient points to determine a curve of moisture gradient through the bed. A suitable time interval is one giving a decrease of about 2 per cent in moisture content.

Table I

Run	Depth of bed, in	Air flow, lb/ft²-min	Moisture content, lb/lb			Air temp., deg. Fah.	Air R.H., per cent	Wet bulb temp., deg. Fah.	Time to dry, min	Rate of drying, hr^{-1}	Effect. mean temp. (eq. 3)	Log. mean temp.
			Initial	Final	Equil. (Fig. 1)							
42	1·1	3·3	0·33	0·121	0·093	120	20	82	171	0·225	117	99
43	2·2	3·3	0·33	0·120	0·093	120	19	81	186	0·304	114	99
44	4·5	3·3	0·33	0·190	0·093	120	20	82	148	0·157	89	99
45	2·2	3·3	0·265	0·154	0·100	100	26	72	178	0·163	91	85
46	5·2	3·3	0·265	0·168	0·102	100	27½	73	195	0·121	80	85½
47	2·7	1·5	0·265	0·161	0·102	100	27½	73	210	0·126	81	85½

Variables and Dryer Performance

The semi-graphical method of solution was used to find the influence of common variables on " performance " in through air drying of a static bed of the wheat considered above.



Air drybulb temperature ... ... 100 deg. Fah.
Humidity ... ... 0·0066 lb/lb
Mass flow ... ... 3 lb/(ft²-min)
Initial moisture content ... ... 0·275 lb/lb
Final moisture content ... ... 0·16 lb/lb

Fig. 6—Effect of depth of bed on coefficient of dryer performance

We define " performance " ε as the ratio of the heat equivalent of the moisture evaporated at the air dry bulb temperature to the heat supplied to the drying air, both measured from 60 deg. Fah. and taken per square foot of bed perpendicular to the air flow. Fan work is neglected, since it forms a very small fraction of the energy supplied.

The calculations (summarised in Table II) indicate that for drying wheat in a stagnant bed high performance figures are in every

Table II—(*cf. Figs.* 4, 5, 6 *and* 7)

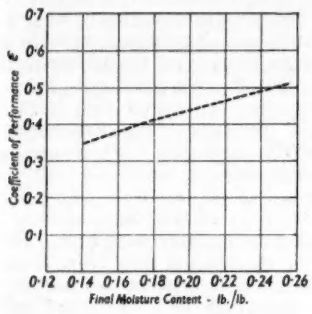
Air supply to dryer at 60 deg. Fah., $H = 0{\cdot}0066$ lb water per pound dry air. Initial moisture content of wheat 0·275 lb per pound, dry basis. Mean value of final moisture content (except D), 0·160.

Investigated	Air temperature, deg. Fah.	Approximate depth of bed, in	Air flow, lb/(ft²min)	Comments
A. Temperature (Fig. 4) : Performance increases linearly with temperature	Varied	6	3	Moisture gradient increases from 6·5 per cent. at 100 deg. Fah. to 13·3 per cent at 140 deg. Fah. High performance may be obtainable using unheated air over a long period of time ; such drying is outside the scope of this paper
B. Air flow rate (Fig. 5) : performance falls approximately inversely with air flow	100	6	Varied	Moisture gradient decreases from 13·1 per cent at 1 lb/ft² min to 5·1 per cent at 4 lb/ft² min
C. Depth of bed (Fig. 6) : performance increases with bed depth at decreasing rate	100	Varied	3	Moisture gradient increases from 2·5 per cent at 2in to 8·7 per cent at 10in. As depth of bed is increased it is possible that dew-point of air may fall to grain temperature and water be deposited near top of bed in early stages
D. Final moisture content (Fig. 7) : performance increases linearly with final moisture content	100	6	3	—

case coupled with a large gradient in moisture content through the bed, giving a very non-uniform product.

Contra-Flow Drying

Performance will obviously be highest when the largest proportion of the outgoing air



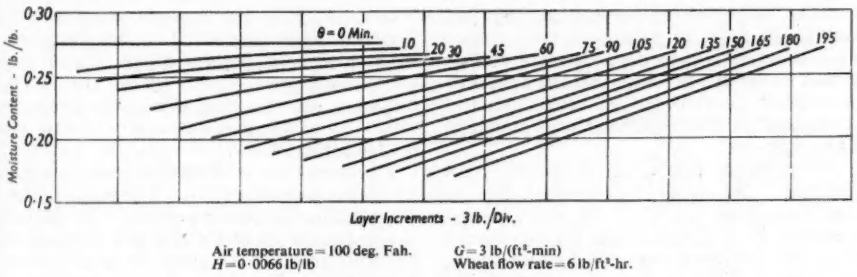
Air drybulb temperature ... ... 100 deg. Fah.
Humidity ... ... 0·0066 lb/lb
Mass flow ... ... 3 lb/(ft²-min)
Initial moisture content ... ... 0·275 lb/lb
Depth of bed 6in

Fig. 7—Effect of final moisture content on coefficient of dryer performance

over the drying cycles is approaching saturation. The contra-flow principle appears to fulfil the requirements of high efficiency and uniformity of dry products. In this investigation an ideal contra-flow dryer is regarded as a deep bed of grain, through which air is passed, and from the bottom of which wheat is removed at a fixed rate and a constant value of moisture content. Fresh grain is fed on the bed to maintain its depth constant. In this way the relative humidity of the outgoing air may be kept at a high value to utilise its drying potential efficiently. After a transitory period at starting up the moisture content of the output would be uniform and depend only on the rate of throughput for constant inlet conditions.

The semi-graphical method may be adapted to solve the transitory state approximately.

As before, for one time interval, calculate the moisture gradient in a number of thin layers, equivalent to the depth of the bed assumed. At the end of each interval, however, some of the leading grain is removed as



Air temperature = 100 deg. Fah. G = 3 lb/(ft²-min)
H = 0·0066 lb/lb Wheat flow rate = 6 lb/ft²-hr.

Fig. 8—Performance of contraflow dryer

required by the flow rate, and an equal (dry) weight of fresh grain added to keep the number of layer increments constant as shown in Fig. 8. The procedure is repeated until a steady state is reached when the slope of the "moisture content"—"depth of bed" curve remains constant with time.

A solution is shown in Fig. 8 for a bed approximately 7½in deep, drying wheat from 0·275 to 0·16 lb/lb moisture content at a performance of 43 per cent. The corresponding performance for the same final mean moisture content in a static bed under the same conditions is 45 per cent, but in contra-flow the outward grain is all at a moisture content of 0·16 lb/lb, whereas in a static dryer it varies over a range of approximately 16±3½ per cent.

Conclusions

(*a*) Efficient practice appears to lie in the further development of contra-flow dryers, operating at as high a temperature as can be permitted, with low values of air flow and a bed sufficiently deep to utilise as completely as is practicable the available drying potential.

(*b*) In the temperature range 70–170 deg. Fah. the rate of drying of thin layers of wheat may be represented by

$$-\frac{\partial W}{\partial \theta}=2\cdot 3m(W-W_e)$$

where m is an exponential function of temperature only and W_e has been correlated as a function of relative humidity and temperature.

(*c*) A satisfactory drying curve can be derived for a deep bed of wheat by regarding it as a number of thin layers in series and assuming that the total heat of the drying air remains constant.

(*d*) The proposed semi-graphical method of solution for deep beds can be adapted to solve approximately the transient condition in a contra-flow dryer.

Acknowledgement

The authors are indebted to Professor A. F. Burstall, Director of the Stephenson Engineering Laboratories, King's College, University of Durham, for the facilities provided, and to their colleagues, Dr. J. S. Forsyth and Messrs. W. H. C. Simmonds and A. J. Nicholson, for their valuable advice and criticisms.

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Woodforde, J.: 1953, *Journal Inst. Fuel*, 25, 327.

Iron and Steel Institute

AUTUMN GENERAL MEETING

No. III—(*Concluded from page* 783, *December 3rd*)

ON the last day of the Iron and Steel Institute's autumn meeting in London, Thursday, November 18th, the morning session opened with a joint discussion of two papers. The first, by F. A. Gray and S. H. Brooks, was entitled "An Investigation of Reheating Furnace Design and Performance." It set out the results of some long and short-period tests which were carried out on a continuous reheating furnace as part of a project designed to provide basic data which would assist in putting furnace design on a more fundamental basis. The many variables affecting furnace performance were measured and their interrelationships studied. Apart from the well-known effect of output on furnace efficiency, it was shown that billets of 3in thickness and greater required more fuel and were associated with higher flue gas losses than thinner ones at a given rate of output. The importance of furnace pressure has been amply confirmed, and quantitative data were presented in the paper showing its effect on air infiltration, blowout, and fuel consumption. The progress of combustion through the furnace was studied in relation to gas flow, furnace pressure, and air/gas ratio.

The second of these papers was by Dr. R. J. Sarjant and Dr. M. R. Slack and was entitled "Internal Temperature Distribution in the Cooling and Reheating of Steel Ingots." It dealt with an investigation of the thermal history of steel ingots from casting to rolling by combining a technique developed for the numerical integration of the heat flow equation in two dimensions, with experimental work on various casting and reheating practices. The paper showed that track time and reheating practice were related to the thermal efficiency and the temperature saturation necessary for good rolling. An expression was derived for the optimum track time which resulted in the most rapid equalisation of surface and centre temperature, although the limiting factor in the reheating for rolling might be the attainment of uniformity of surface temperature.

The next papers to be discussed were:—

THE LENGTH OF OIL AND GAS FLAMES

By A. L. Cude, B.Sc., A.M.I.Chem.E.

Synopsis

The following general equation for the length of free turbulent jet flames has been deduced from the theory of jets and confirmed by experiment

$$L=83\frac{(1+r_t)}{R}\sqrt{\frac{qs'}{u}}.$$

This equation can be applied to fuels of widely differing calorific value, liquid and gaseous. A relationship has been found by which this length can be corrected for the effect of the combustion air momentum, which shortens the flame considerably when it is greater than the fuel jet momentum. A further correction for the elongation due to limited excess air has been deduced from the results of cold model experiments.

The length of a straight jet flame should not exceed 3·5 chamber diameters; if it does, interference from the walls reduces the combustion rate and increases the risk of bad combustion.

Swirling flames expand more rapidly and are affected earlier by the walls, but are not much shorter than straight flames. It is recommended that such flames should not be longer than half a chamber diameter.

MEASUREMENT AND INFLUENCE OF PREHEAT IN THE OPEN-HEARTH FURNACE

By W. P. Cashmore

Synopsis

The variations in preheat within a particular heat of an O.H. furnace are considered, and also trends with time within a campaign. It is shown that an increase of 100 deg. Cent. in the preheat leads to an increase in working rate of about 0·5 tons per hour and a reduction in fuel consumption of 2 to 3 gallons per ton.

Comparison of the working rate and fuel consumption as functions of preheat for particular designs of single-uptake and double-uptake furnaces suggests that the former give better results for a particular preheat. However, this advantage is offset to some extent by the increased pick-up of preheat due to the greater surface area of the brickwork in the uptakes in the latter, which results in a higher preheat for a given regenerator capacity. The apparatus and

experimental technique used to effect the measurements are discussed.

Discussion

Mr. R. Barber (Land Pyrometers, Ltd.) : My comments will be restricted to one aspect of Mr. Cashmore's paper. The author's work will almost certainly lead others to try something of the same kind, and this is therefore an opportune time to emphasise the importance of using fairly accurate temperature measuring devices and the dangers of using inaccurate ones. In the past, pyrometers have been used comprising a single radiation shield surrounding a thermo-couple sheath, and we now know that they are inadequate and probably operate at less than 50 per cent efficiency, which means that when the suction is turned on the temperature will change less than halfway to the true gas temperature ; and, as the author shows, temperature differences exist of more than 200 deg. Cent., which means that the pyrometer will be more than 100 deg. Cent. in error. It also means, which is just as important, that a 50 deg. Cent. change in the temperature of the surroundings will have the same effect on the pyrometer as a 50 deg. Cent. change in gas ; it is not possible to differentiate one from the other. Because of this, it is dangerous to report results of this type without very careful consideration. Mr. Halliday used a single-shield pyrometer to start with. Even two shields are far from ideal, and if they get dirty may operate at only 70 per cent efficiency.

Refractory shields are more efficient than metal shields, because refractories have lower conductivity, so that a refractory shield may, when new, be worth two or even three metal ones. It is important to realise, however, that the increased efficiency and accuracy obtained from the refractory shield is due almost entirely to the reduced emissivity, and if refractory shields become dirty and the emissivity increases they will not be much better than a metal one. I emphasise that strongly. People who use refractories should be careful to see that the effect of ageing is not to reduce the efficiency. Do not carry out all your work with new shields.

Mr. R. W. Evans (Steel Company of Wales, Ltd.) : I propose to devote most of my remarks to Mr. Cashmore's paper. I have a deep-seated conviction that preheat is one of the most important factors when we consider the efficiency of modern open-hearth furnaces, and I do not think that in the past its importance has been fully realised. Marsh by his work at Bethlehem has shown that for 100 deg. Cent. extra preheat he reckoned to get 16 per cent increased production. The author mentions 10 per cent, but Marsh actually thought that he got 16 per cent increase in production, which is very significant. Historically, the importance of preheat has been partly recognised, because over many decades a large number of patents has been taken out for different designs of checker work and checker brick, and there was no doubt that that work was directed to getting the furnace to work faster, even if people did not know quite why that happened, and it was also associated with the desire to keep the checkers on the outgoing end of the furnace reasonably free.

One important question to consider, if we say that we are getting increased production or an increased working rate out of a furnace which has a high air preheat, is exactly where that increase comes. I submit that it comes largely during the melting period and not during the refining period. The effect of the higher preheat is to give a higher flame temperature, and that leads to an increased capacity or speed of melting scrap. I cannot see that one should expect an increased speed of refining, but, as the author says, one should expect a lower fuel consumption during refining by maintaining a high preheat. I believe that the major benefit, however, is to be expected during the melting operation, and I should like to ask the author whether during his investigations the increased speeds which he has found with increased air preheats have in fact been associated with charging and melting, and not with refining. One corollary would be that tilting furnaces which use up to 80 per cent of hot metal, as against, say, 50 per cent of hot metal in a fixed furnace, might expect less benefit, because they use less scrap and have to melt less.

Mr. R. Mayorcas (B.I.S.R.A.) : It cannot be argued that we want more preheat. Professor Thring has calculated that an extra amount of preheat is of value, but it has also been calculated that 10 deg. Cent. higher roof temperature will give an increase in output, and it has often been shown that an increased fuel input to the furnace will give a greater output. If we now merely plot the results of a furnace working, putting one thing against the other, we are almost certain to get relationships, but on a system such as that of the open-hearth furnace, where almost everything is interrelated, it is very hard to say that these experiments show that a 100 deg. Cent. preheat increases the output by so much. What we want to know is how to increase the preheat by 100 deg. Cent., not that if it is so increased it will give such-and-such a result, because we still do not know how we get it.

Let us look at the scatter. The scatter, nevertheless, results in a very impressive significance of 1 in 100 and 1 in 1000, but it takes thirty-three casts to obtain this significance, and the scatter is from 26 gallons per ton to 36, while the preheat scatter is from 1120 to 1350 deg. Cent., and the average weekly production in tons per hour from 10½ to 13½. I submit that we are not going to have a single cast measurement of any use to us because of this scatter, and no management needs continuous measurement of heat to know that something like blockage of checkers is taking place. I think it is wrong, because we have not controlled any one variable in order to produce a result which we can say definitely depends on a change of that variable. I believe that the approach of B.I.S.R.A. through the steel practice committee and the instrument sub-committee is the right one.

The manager wants two things from his checkers : he wants high preheat, but he also wants long life. It is no good having a preheat of 1500 deg. Cent. for two weeks if on the following week the furnace is out of action. The approach adopted by B.I.S.R.A., therefore, is to see whether we can clean the gases first by proper design so as to take advantage of better designs of regenerators, which will be more efficient with the higher velocities and so that at the same time we shall have regenerators which will last longer and which will give higher preheat.

Mr. Sidney Williams (Guest, Keen Iron and Steel Company, Ltd.) : Referring to Mr. Cashmore's paper, as the author has pointed out, these investigations really started owing to some remarks of mine. To bring you back to the history of the beginning of these investigations, what happened at Cardiff may provide a better chance of realising the importance of air preheat. As I think that most people in the steel trade are aware, we at Cardiff were among the first in the country to adopt 100 per cent liquid fuel firing. Our first attempt at liquid fuel firing was remarkably good ; in fact, in my opinion as manager of the shop, it is only on a few occasions that we have equalled that first attempt which we made at fully-firing a furnace with liquid fuel. When we started we did remarkably well, but as the furnace was allowed to remain for longer periods on liquid fuel the efficiency of the furnace fell off. We could not quite understand it, and we found that with other furnaces the same thing happened. We were unable to measure air preheat as we do to-day, because we could only take a spot test, but we noticed, taking checker temperatures, that the efficiency went back as checker temperature went back. It was a pity that we did not have Mr. Cashmore with us at that time, or we should have moved more quickly and found out far more. When he joined us he was asked to carry out these investigations, and he has proved without any shadow of doubt, not only to myself as manager of the plant but also to our workmen, that air preheat is one of the most important factors in the operation of an open-hearth furnace.

There is still a great deal of work remaining to be done on air preheat. One speaker has asked how we get the higher temperature. There are several factors. First of all, it is necessary to have good combustion. Not always, though your waste gas temperature may be high, do you pick up air preheat in the furnace. You have to pay attention to the flow pattern of your waste gases passing out to the checkers. Unless the fantails of your uptakes are so designed that you have an even distribution over the top of your air checkers, you will not get the best air preheat, because you will form channels, and when you do that you will not bring the air back through the hottest part. Again, the quality of the brick has an important part to play. We know from experience at Cardiff that after a furnace has worked for a certain period we get the checkers crossing over and a very small variation from one to the other. As the brickwork deteriorates that gap widens and the average air preheat drops. That calls for a good deal of investigation. I know that as the brick within the checker starts to slag up the air preheat drops. Although the checker temperature according to the brickwork is recorded, the air preheat drops because you have heated the outer face of the brick, but have not the heat within the brick to follow up as you run the cold air in to put the heat into the air.

Infiltration is one of the worst things which can happen within a regenerator from the point of view of air preheat. The author has proved to us at Cardiff, not once but a hundred times, that infiltration is about the worst thing that can ever happen to a regenerator. We have had checker temperatures up very high, and when we measure air preheat it has been very little above the checker temperature, and sometimes a shade below. When we find that we have gone over the furnace with a little instrument which the author has designed for us to find out where air infiltration takes place, and each time we have managed to seal up all the infiltration, our air preheat has gone up. Another important factor is provided by the slag pockets and air uptakes.

Mr. G. G. Thurlow (B.C.U.R.A.) : I have very little to say on Mr. Cude's interesting paper, except perhaps to sound a note of caution concerning the assumption, now so commonly used as to be almost axiomatic, that the rate of combustion is purely a func-

tion of mixing. Evidence has recently been obtained by us that this is not strictly true in a fuel bed, and I am not happy about it being applied to all flames.

Mr. Cashmore's paper I found most interesting, not only for the actual results obtained, but as an example of the difficulties of getting clear-cut results from tests on actual furnaces, where so many factors are beyond the experimenter's control. The author is to be congratulated on the clearness of the conclusions reached ; at the same time, it is particularly important in tests of this sort to be doubly sure of the experimental and analytical techniques which are used. I do not propose to say anything about the accuracy of suction pyrometers, but I have a small point on the question of interpretation. When people talk about preheat and waste gas temperatures, what is often meant is the heat content of the gas in B.Th.U. or therms per cubic foot. This is all right when talking about sensible heat, but needs further consideration if total heat is required. The effect of the latent heat of the moisture is probably well enough appreciated. The moisture in the preheat passes through the system without change of state and does not have much effect, but the steam injected and the moisture formed during the combustion add, in the case of an oil-fired open hearth, heat to the waste gases equivalent to the sensible heat produced by a change in gas temperature of about 70 deg. and 180 deg. Cent. respectively.

Mr. John W. Till (John Summers and Sons, Ltd.) : I think that there must be general agreement with the author that high air preheat temperature is desirable for the efficient working of furnaces. Probably we shall all agree on the factors which are responsible for differences in preheat between one furnace and another. They are presumably the design of the regenerator, the type and quantity of the filling, the design of the slag pocket and uptakes, heat losses through the brickwork, and the kind of fuel used. We can assume that the factors responsible for the differences in preheat during a campaign on a particular furnace are alteration in the amount of air infiltration, change in heat transfer in the regenerator, due either to blocking up or to glazing of the checker brickwork, fuel input, and possibly the kind of fuel. Moreover, there are checkers which are not fully heated up in the early part of a campaign, and there is also the factor of the loss of draught, which becomes very obvious. The author has given us an instrument which provides a rough and ready means of checking many of these things on the furnace.

Dipl.-Ing. G. Wellensiek (Metallurgical Engineers, Ltd.) and Mr. A. B. Pritchard (Shell-Mex and B.P., Ltd.) also spoke, after which the authors of the two papers made brief replies to points raised in the discussion.

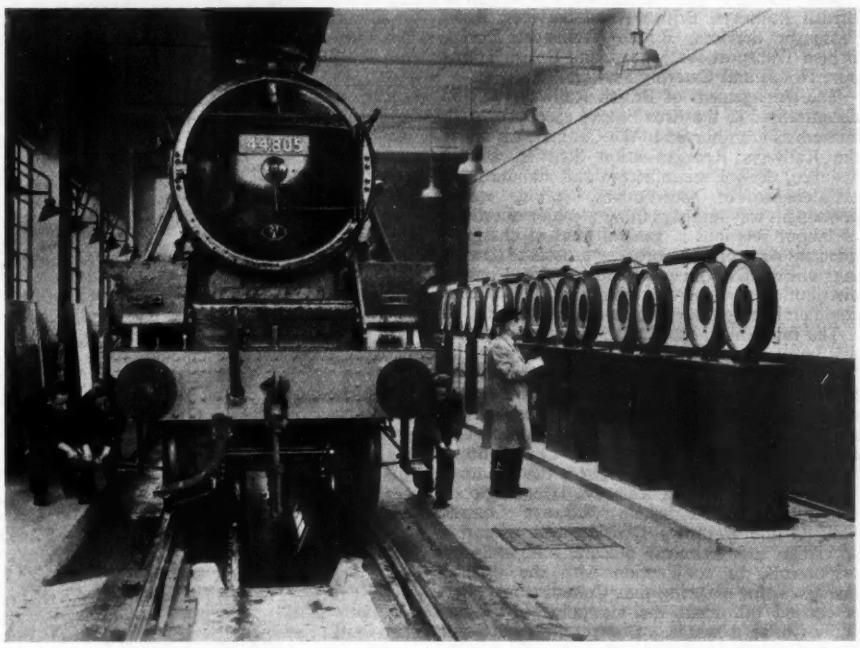
At the final session of the meeting, on Thursday afternoon, November 18th, Mr. P. H. Frith presented for discussion the Iron and Steel Institute's special report No. 50, entitled " Fatigue Tests on Rolled Alloy Steels Made in Electric and Open-Hearth Furnaces."

MOTOR INDUSTRY SUMMER SCHOOL.—The Institute of the Motor Industry has arranged to hold its ninth annual summer school at Corpus Christi College, Cambridge, from August 20 to 27, 1955. The curriculum of the last summer school comprised lectures on management, economics and industrial relations, higher techniques of accountancy and commercial practice, practical financial controls, the principles of law (particularly in relation to the motor industry), and sales promotion, and was based on the preferences of those attending. It is proposed to adopt a similar method in arriving at the syllabus of the ninth annual summer school.

Locomotive Weighing Machine

THE illustration on this page shows a new locomotive weighing machine which has recently been installed at the locomotive works at Crewe. This machine was designed and built by Henry Pooley and Son, Ltd., and is capable of accommodating all classes of locomotives in service on British Railways.

The machine consists of seven pairs of tables, each 7ft long, spaced ½in apart, and giving fourteen individual wheel weighing units. Each of these units has a weighing capacity of 20 tons and the weight is registered on a dial indicator graduated by 1-cwt divisions.



Locomotive weighing machine installed at Crewe works. This machine has seven pairs of tables each of twenty tons capacity and can be used with all the classes of engines in service on British Railways

In this installation dead sections between each pair of tables are eliminated and the immediate indication of all wheel weights on the dial indicators enables the observation of weight variations as spring adjustments are made. Locomotives are positioned centrally on the rails by check rails on each table. A walkway provided down the centre of the tables is 2ft 6in deep and 1ft 4in wide at the lower part, opening out to 2ft 3in at the top, and it is equipped with fluorescent lighting. All the dial indicators are fitted with a coupled relieving mechanism and are put in gear by the operation of a centrally placed lever. The dials are illuminated by fluorescent tubes.

This new locomotive weighing installation is housed in a building specially designed by British Railways. It has sliding doors at each end and, outside, an inspection pit equipped with fluorescent lighting has been installed.

British Transport Commission Organisation

FOLLOWING the approval by Parliament of the Railways Reorganisation Scheme, which provides for the introduction of Area Boards, it has now been found possible to effect a further reorganisation and some reduction in size of the British Transport Commission's headquarters, and at the same time to introduce certain other changes thought to be desirable. Among these are the change of title of chief regional managers of railway regions to general managers, and the separation of docks management from waterways.

The new organisation will supersede the interim one in force since October 1, 1953 (when the former executives, except the London Transport Executive, were abolished) and will operate from January 1, 1955. In revising the organisation, the principles followed are to leave management to the Commission's subordinate organisations, to keep the organisation for control clear and simple, and to restrict within practicable limits the number of bodies and people with whom the Commission normally deals direct. In pursuit of these principles, the revised organisation is planned to arrange the work of the members of the Commission on a pattern which will ensure that proper watch and control is exercised on all parts of the undertaking, and to provide the Commission with a relatively small but compact headquarters staff machine.

Under the new organisation there will be direct channels of control from the Commission, first through the Area Boards to the six railway regions ; secondly to the London Transport Executive ; thirdly to the divisional managements of the Commission's other principal undertakings and, fourthly, to various other activities.

Much of the work performed by members of the Commission—apart from and to a large extent preparatory to final policy decision, if required, at formal meetings of the full Commission—will be carried out by committees and sub-commissions composed of commission members. This will simplify procedure and facilitate quick decisions.

The committees of the Commission will deal with matters relating to the whole of the Commission's activities, including finance, establishment and staff, technical development and research, works and equipment, property and stores. These committees will be analogous to the committees of directors appointed by the boards of the former railway companies.

The sub-commissions will comprise small groups of members devoting special attention to one of the Commission's activities, such as railways, road haulage, road passenger, London Transport, shipping, docks, inland waterways, hotels and catering, &c.

The railways sub-commission in particular will act as arbiter on day-to-day matters requiring co-ordination between the regions, and will generally watch the performance and productivity of British Railways, drawing attention to any need for improvement which it considers necessary, either through the general managers or (as regards anything which it feels warrants action at Area Board level) through the Commission itself.

The advisory bodies of the Commission are,

respectively, the Research Advisory Council and the British Transport Joint Consultative Council, both of which include representation from outside the Commission's organisation.

The general staff of the Commission, under a secretary-general, will cover the activities of the whole of the Commission's undertaking, and will channel all communications from the areas, London Transport, divisions and other authorities, after such co-ordination as may be required, to the appropriate committee or sub-commission. The officers and advisers forming the general staff will work with small personal staffs.

The divisions of the B.T.C. will comprise British Railways, British Road Services, Road Passenger Services, British Transport Docks, British Transport Waterways, and British Transport Hotels and Catering Services.

The management of British Railways will be decentralised to the Area Boards except for such matters as are reserved to the Commission under the Railways Reorganisation Scheme, as for instance, design, manufacture and standards of maintenance of locomotives, rolling stock, permanent way and signalling ; major questions of labour relations ; general level of charges ; financial control in its broader aspects ; operating policies and principles ; inter-regional wagon distribution ; general commercial policy and commercial negotiations on a national basis.

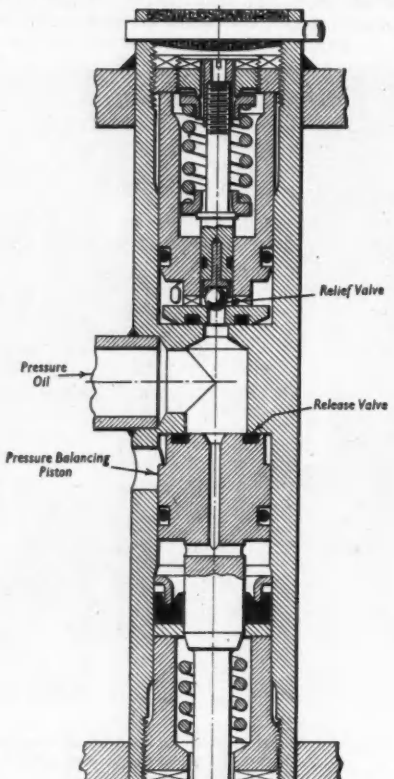
The function of the British Railways division will be to implement Commission policy on the " reserved " matters concerning all lines and to furnish advice, co-ordinated with the regions on new policy in these directions, and on matters affecting the railway regions as a whole. The division will consist of a Railway Central Staff, a General Manager's Committee, the Clearing House and the British Railways Inter-Regional Committees. The British Railways Central Staff of the Railways Division will comprise specialist and technical officers, who will be responsible, in conjunction with the general managers, for ensuring that Commission policy is carried out from the viewpoint of British Railways as a whole. Contact in day-to-day matters will be maintained between the British Railways Division and the regional departmental officers, the general managers being kept informed.

Each of the following other divisions will be run by a management board, of which the general manager will be chairman, the members being selected from his departmental officers : British Road Services, British Transport Docks, and British Transport Waterways. The Tilling Group and the Scottish Omnibuses Group will constitute separate divisions for the management of their respective groups of companies. The British Transport Hotels and Catering Services will be run by a general manager.

The Central Services of the Commission which were previously known as " Common Services," will give specialist service to the various parts of the organisation. The Central Services will be concerned with archives and historical records, registrar's records of railways and canal securities, estate and rating, legal services, police, stores, paper and printing, films, commercial advertising, and the preservation and display of historical relics.

Hydraulic Mining Equipment

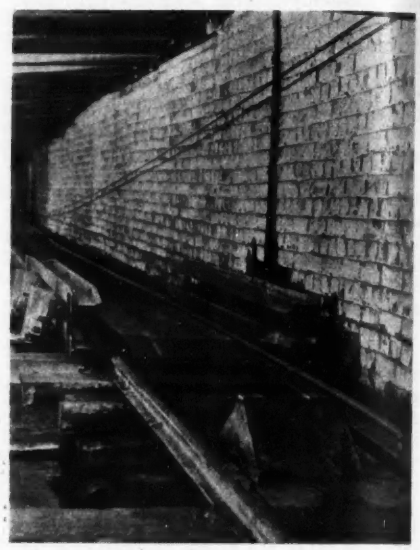
SINCE the war there has been a notable increase in the use of hydraulically operated mining equipment at the coal face. One of the first major applications and one of particular interest was the hydraulic prop developed by Dowty Mining Equipment, Ltd.,



Section through relief and release valves of 80-ton chock

and introduced in 1946. This unit greatly influenced roof support technique and the physical and physiological advantages bestowed are now fairly well recognised.

The standard prop was briefly described in our issue of June 15, 1951. It gives full support with a few strokes of a pump handle and offers a 20-ton resistance to roof convergence. Should pressure exceed 20 tons a relief valve allows the prop to yield while continuing to offer a 20-ton resistance. Consequently, in an area where the roof is supported entirely by hydraulic props uniformity of resistance is provided and dangerous roof breaks are avoided. Where rigid props are used differential stresses imparted to the strata tend to break the roof and control becomes difficult. The speed with which hydraulic props can be removed (approximately ten seconds) or reset at a high initial load (approximately forty-five seconds) in safety is another factor leading to flexibility of support systems, and obviating the time wastage in removing and repositioning tightly wedged wooden props. Their higher



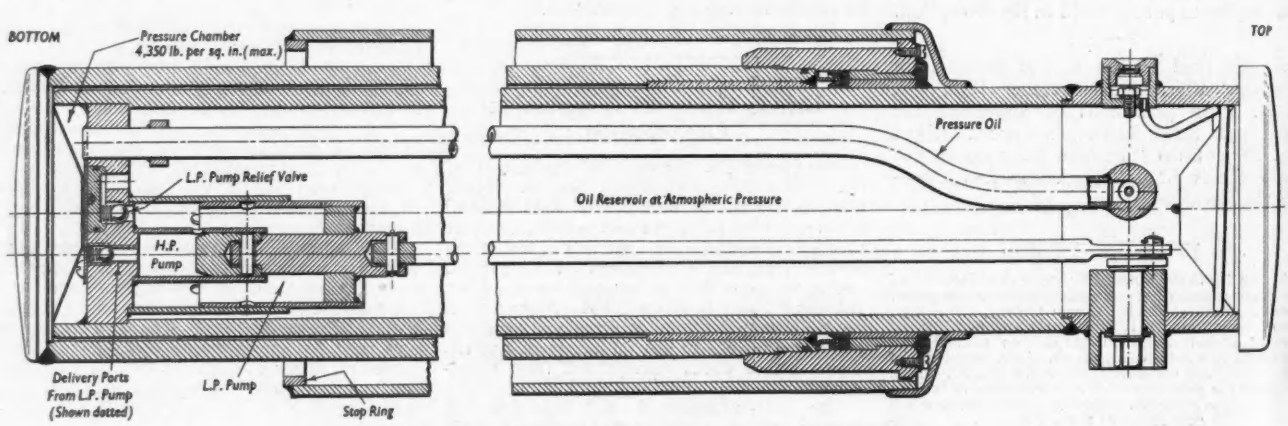
Hydraulic tub retarder and jack-operated safety stop

initial cost, it is claimed, is offset by their greater efficiency in operation and by the elimination of the considerable wastage associated with other kinds of props. The annual loss of hydraulic props is stated to be of the order of 2 per cent.

We have obtained from the same company details of other hydraulic equipment which it has since developed.

Apart from the development of larger props of up to twice the standard size, the company has designed a dynamometer, basically similar to the prop, which is used to test roof and floor strength, thereby indicating variations in pressure during coal-getting operations and facilitating accurate observation of roof convergence.

Based on the same principle also is the 80-ton chock for waste edge support, recently intro-



General arrangement of 80-ton chock for waste edge support

Hydraulic tub thruster

duced, and illustrated in the drawings on page 822. It will be seen that the main structural members are two telescopic cylinders with radiused end caps welded on. The inner member, which has its other end closed by a welded piston head assembly, is partially filled with oil at atmospheric pressure. In the drawing the unit is shown in the fully closed position and with a closing load of 80 tons fluid pressure between the two cylinders is 4350 lb per square inch. Details of the single bearing sleeve and high pressure seals used in this particular design are clearly shown.

The concentric cylinders of the hand-operated hydraulic pump are welded on the internal face of the ram head. The inner cylinder is worked by the high pressure piston which is integral with the annular piston of the low pressure pump and slides in the annular space between the pump cylinders. Both the l.p. and h.p. cylinders communicate with the pressure chamber of the ram by spring-loaded ports in the ram head.

With both pumps in operation the large delivery enables a high rate of extension to be obtained until a roof load is developed and it is necessary to develop the setting load of 20 tons. A relief valve shown in the ram head then opens and oil swept by the l.p. piston is by-passed to the reservoir. The support load is thus only developed by the h.p. pump. The piston is reciprocated by a crank pin through a rotary screw key.

The pressure chamber communicates with the reservoir through a combined relief and release valve which are both shown closed in our first drawing. A simple spring-loaded ball orifice serves as the relief valve shown in the upper section (according to the drawing). In the release valve the valve member is balanced by the admission of pressure oil to both faces and is retained closed by a spring. It is displaced axially by the hand lever and a cam which is not shown.

Tub thrusters, retarders, stops and points switches are the other principal applications of hydraulic plant. Tubs at the pit bottom can now be controlled by one man who manipulates levers from a central control station. The levers actuate valves which direct fluid pressure from an electro-hydraulic power pack to selected equipment. These packs give deliveries of up to 16 gallons per minute at working pressures up to 850 p.s.i. The largest unit has a 12½ h.p. electric motor driving twin pressure-balanced gear pumps.

There are several kinds of hydraulic tub retarders, the most common consisting of twin retarder rails on each side of the rail track as illustrated. One set of rails is rigidly secured to the base structure and the opposing set, mounted on pivot arms, is actuated by hydraulic jacks. The retarder rails carrying rubbing strips are hinged to the pivot arms so that equal pressure in operation is applied above and below tub wheel centres, thus balancing the brake effect. One kind of retarder can hold up to seventy tubs with a gross weight of 100 tons on straight road gradients of 1 in 36.

The tub thruster illustrated herewith is also operated from a power pack. It is a welded steel structure embedded between the rails and consists of a sliding panel which moves along guide rails impelled by a quick-acting hydraulic jack. Four thrust plates carried on the panel are arranged to swivel forward on a ratchet principle, allowing tub axles to pass over, balance weights returning the plates to the thrust position. The developed thrust against tub axles is 2000 lb and the travel from 2½ft to approximately 5ft at 1ft per second. An automatic reciprocating version which operates for periods without attention can be fitted where a continuous flow of tubs has to be handled. Similarly, other systems (such as the one illustrated on this page) employing remotely controlled jacks, are being used for switch points at junctions; the operation of tilting platforms and floating platforms; air-lock door operation ensuring that air flow systems are not disrupted by passing tubs; the control of tippler gear operation; safe remote control of chute doors with minimum interruption of flow of coal from conveyor to tubs; and for kep gear operation where hydraulically controlled pivots for cage support are claimed to have various advantages.

Continuous tub control covering a series of operations at the pit head. Retarders, points and tipplers are controlled by one man through an electro-hydraulic power pack

Institution of Water Engineers

THE Institution of Water Engineers held its fifty-ninth winter general meeting on Friday last, December 3rd, when the president, Mr. N. G. Elliot, was in the chair and three papers were presented for discussion.

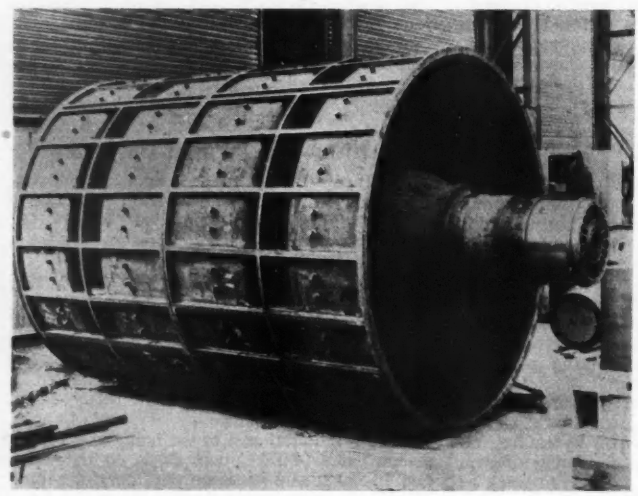
Mr. A. G. McLellan was the author of the first paper, which was entitled "The Lining with Rubber of a Large Service Reservoir Damaged by Mining Subsidence." The reservoir concerned was the Sunderland and South Shields Water Company's 12 m.g. service reservoir No. 2 at Mill Hill, which was completely lined with ¼in thick rubber sheeting, at a cost of about £68,000; the total area of the lining was 14,660 square yards (4,070 square yards on the walls and 10,590 square yards on the floor), the total weight of rubber involved being about 100 tons. The design of the lining, it is pointed out, was the outcome of a process of evolution over a number of years, and the chief interest lay not so much in the nature as in the magnitude of the task, the only alternative to which was the construction of a new reservoir, at a cost of perhaps £200,000. An outline of the evolution of the design of the lining, and of the detailing of the final design are given in the paper. The preliminary work started with small-scale repairs, and a small area of the No. 1 reservoir was then lined to determine whether the scheme was practicable; as a final test the mixing chamber was lined before the final project was decided upon, and it was at this stage that many points of difficulty were cleared up, including confirmation of the fact that the lining did not affect the taste of the water. It is expected that the reconditioned reservoir will have a life of at least twenty years, and possibly much longer.

The second paper of the meeting was entitled "The Coldharbour Experimental Siphonic Tidal Outfall," by R. Berkeley Thorn and W. J. Kenyon. The Coldharbour outfall is one of three on the north coast of Kent which drain an area of 18,300 acres of predominantly marsh land. When it was due to be reconstructed, estimates showed that a tidal outfall siphon would give an economy in cost of nearly half over the orthodox gravity culvert, but there were a number of difficulties to be overcome; little information seemed to be available in the design of such outfalls, for whilst a comparatively large number of high-velocity siphons have been built, low-velocity siphons which have to carry over appreciable quantities of air, are rare and little has been written about them. The outfall was destroyed during the storm and tidal surge of February 1, 1953, but by then sufficient information had been gathered to indicate the possibilities of the design. The paper includes a design for an outfall of this kind with a calculated discharge capacity of 120 cusecs.

The final paper of the meeting, "Artificial Replenishment of Aquifers," by Stevenson Buchan, reviewed the experiences of several countries in supplementing ground water by artificial methods, and discussed the possibilities of adopting this practice in England. The marked increase in the use of ground water for public supply—estimated at 535,000 m.g. in 1953—drew attention to the use of artificially introduced water, the author pointed out, not only as a means of halting over-development, but also of reversing the trend of water levels, and for restoring the usefulness of the ground water reservoir in coastal areas by using artificially infiltrated water of suitable quality to drive out infiltrated salt water. Areas where such methods could be used are mentioned in the paper.

Welding in a Large Engineering Works

DURING the past few years a programme of extension and re-equipment has been in progress at the Colchester works of Davey, Paxman and Co., Ltd., and in the course of a recent visit to these works we were given an opportunity to see the extent the firm now makes use of welding in the manufacture of its oil engines, boilers, filters, and a variety of other plant it makes to special requirements. It is of interest to note that the firm introduced welded steel frames for its oil engines as far back as 1931, and this kind of fabricated frame in both steel and light alloys is now widely used in the construction of engines of up to 2000 horsepower. With the development of new welding techniques and equipment the latest methods of fabrication were progressively introduced in the other departments concerned with the manufacture of boilers, filters and general engineering products.



Fabricated mild steel 300 square foot rotary vacuum filter drum

In revising the layout of the main welding bay the old canvas screens have been replaced by cubicles built from standard "Dexion" metal sections and hardboard panels. Each cubicle is fitted with a large sliding door and large workpieces are handled by an overhead crane serving the length of the shop. The use of hardboard panels for the cubicle walls, in addition to being convenient, enables them to be replaced quickly and easily if they are damaged. All plate preparation, fabrication and machining is carried out in the same shop, and the stress relieving facilities are being supplemented by a new gas-fired furnace, to take vessels 27ft long and 9ft 6in diameter, which is at present in course of construction.

The three methods of welding in general use in the shop are the inert gas shielded process, the argon arc process and the automatic submerged arc process. The inert gas shielded process using "Aircomatic" or "Argonaut" equipment is mainly used in fabricating heavy section non-ferrous metals and stainless steels. We were shown some good examples of the strong and rigid structures which the firm is producing in aluminium alloys by this process. One example was a crankcase for a sixteen-cylinder oil engine with its underbase built up of 1in thick 5 per cent magnesium-aluminium alloy plate with 4in by 2½in bearer bars and 12in by 4in channels.

The argon arc process is used in the production of components in light non-ferrous plate up to $\frac{3}{16}$in thick, such as sumps, manifolds, silencers, &c.

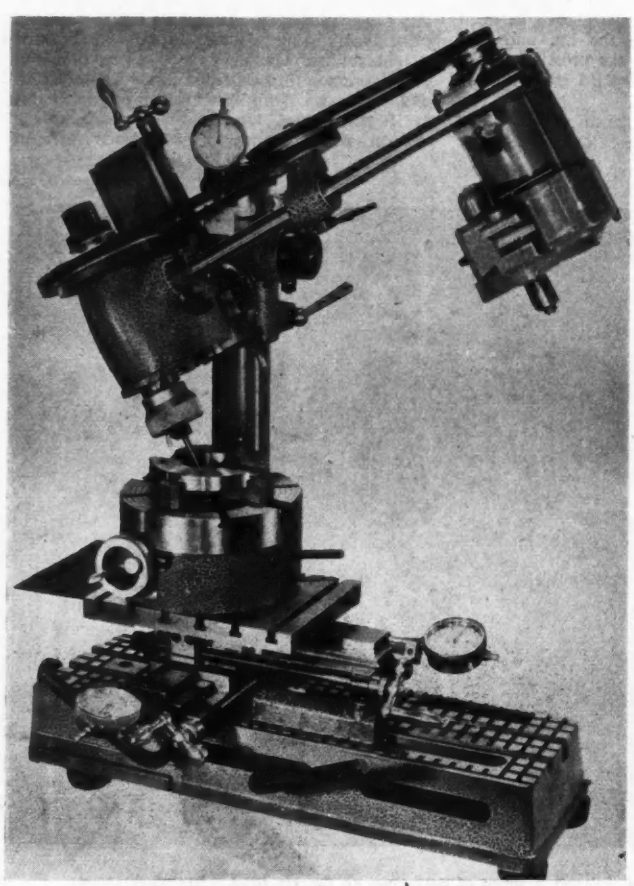
For welding such components as mild steel flues for boilers, pressure vessels, shell boilers, &c., a "Lincolnweld" automatic submerged arc welding equipment is mounted on a manipulator. On this equipment the work can be rotated at controlled speeds for circumferential welding or the welding head can be traversed along an overhead arm for longitudinal welding.

An X-ray plant has been installed at one end of the shop for the examination of fusion-welded pressure vessels. This 250V "Raymax" equipment is capable of examining steel sections up to 3in thick and is arranged on a carriage so that it can be traversed with ease along large workpieces. Portable lead screens round the equipment can be arranged in accordance with the size and shape of the vessel undergoing examination.

One class of work in which welding is used to a very large extent is in the manufacture of the firm's rotary vacuum filters. These filters are built in sizes from 2½ square feet to 700 square feet, and although some are made in cast iron, a large number are fabricated in mild steel, stainless steel, aluminium, Monel metal, &c. A typical fabrication of this kind is the 300 square foot filter we illustrate on this page. This filter is fabricated from mild steel plate and is mounted on cast iron trunnions; it weighs some 15 tons and is 8ft diameter by 15ft long. The welding involved in this filter can be appreciated when it is pointed out that each drum box consists of a number of vacuum and pressure-tight cells communicating with ports in the trunnion.

Multi-Purpose Machine Tool

DETAILS have reached us of the "UWG" multi-purpose machine tool made by Hommelwerke G.m.b.H., Mannheim-Kaefertal, Germany. It is stated that the design makes it possible to carry out any of the principal machining operations such as turning, milling, jig boring or grinding, by suitably setting up a number of basic machine tool components. As an example of the many ways in which this may be done, the illustration below shows the machine set up as a jig borer. A ground cast iron bedplate carries a co-ordinate slide, and a rotary table and chuck in which the workpiece is mounted. The boring head, complete with drive, is bolted to a cross slide fixed to a vertical slide rest. The column as a whole may be swivelled about a vertical axis, and can be clamped in any position, thus making it possible to set up the spindle axis at any angle required. All three co-ordinates can be varied by means of slip gauges and dial indicators as shown in the illustration.



Multi-purpose machine tool set up as a jig borer

The advantage claimed for this equipment, particularly in the small workshop, is that a great variety of operations can be performed which would normally require a number of specialised machine tools.

The versatility of the machine makes it possible in many cases to perform different operations in sequence without disturbing the setting of the workpiece, thereby increasing the accuracy. In research and prototype work, small components can be turned out quickly and without interrupting work on machines used in other departments of the factory.

The maker of the machine is represented in this country by Catmur Machine Tool Corporation, Ltd., 103, Lancaster Road, London, W.11.

Stress Corrosion Cracking of Gas By-Product Plants

WE have received a communication from the British Welding Research Association with regard to a recent survey of sixty-seven gasworks installations where stress-corrosion cracking had been reported. It states that a committee of the Association, although still awaiting the final analysis of the reports, considers that certain conclusions are justified. These conclusions are listed as follows:—

(1) Stress-corrosion cracking is not limited to welded gas mains, but appears, though less frequently, in welded vessels.

(2) Its appearance has been found to be not related to any group of coals or any kinds of carbonising plant. No cases connected with water gas are known, and producer gas is not seriously suspected.

(3) The range of expected occurrence is now extended to include the foul main and terminate at the outlet of the final ammonia washers.

(4) Stress relief, by heat-treatment, to a not unduly exacting specification, is apparently able to prevent its appearance entirely, and probably also to meet the effects of added strains such as arise from mechanical vibration, ground movement, &c., if these are not excessive. Shot peening has not been tested with equal thoroughness.

(5) Previously stress-relieved work should not be rewelded for alterations without afterwards restoring the stress relief.

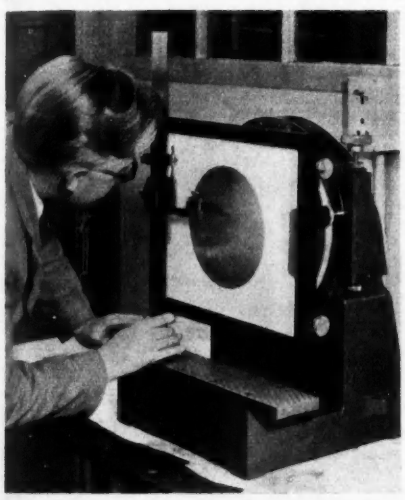
(6) High quality of welding does not confer immunity, and there are some doubts in regard to riveted work being completely resistant

It is stated that the interim report conveying these conclusions has been circulated to the authorities directly interested in the manufacture of coke and gas.

Fixture for Making Master Layouts for Projectors

A LAYOUT fixture which is designed to speed the accurate preparation of master layouts for use on a projector is now being made by the Aldridge Tool and Engineering Company, Ltd., and marketed by Alfred Herbert, Ltd., Coventry. It is stated that the fixture can be operated by a person having only a basic knowledge of trigonometry and able to use a vernier height gauge and vernier protractor.

The fixture can be seen in use in the illustration below. It consists essentially of a strong base with a table arranged in front of a column on which there is mounted a protractor head. This head can be rotated through a full circle and is fitted with a spring-loaded plunger, which accurately locates it at 15 deg. intervals. An angular vernier graduated in minutes is used to set the head at intermediate angles. A metal frame



Making a master layout for use on a projector using the vernier height gauge and vernier protractor head of the fixture

clamped to the front of the head is designed to take a rectangular sheet of transparent plastic forming a screen of similar size to that of a Hilger projector.

The principle of this system of layout production lies in a simple graphical solution of the form required, which in turn is used in the fixture to produce the final layout through the medium of an ordinary vernier height gauge.

The dimensions on the component drawing are first multiplied by a predetermined constant to give the required magnification. The approximate outline of the magnified form is then sketched out on a sheet of graph paper with pencilled notes to indicate the relative positions of the various planes and radii.

The metal frame is removed from the fixture and a sheet of the recommended layout material is placed on the plastic screen. Upon being smoothed over with a brush or piece of cloth this will adhere to the " Perspex." The graph paper is placed behind the screen and the metal frame refitted to the head. It is then a simple matter to build up the magnified form from the notes made on the graph paper by using a vernier height gauge in conjunction with the protractor head to scribe the outline into the surface of the layout material. The layout is completed by adding the radii with a pair of dividers and then rubbing a little micrometer blue into the grooves so formed.

Vertical Boring Mill with Electro-Hydraulic Control

A VERTICAL boring and turning mill for work up to 39in diameter now being made by Schiess A.-G., Dusseldorf, Germany, is arranged for either manual or semi-automatic operation in which the operator simply loads and unloads the work and starts the automatic cycle. As can be seen from the photograph we reproduce on this page, the machine itself is generally of the firm's standard design. It is, however, fitted with an electro-hydraulic control mechanism which can be preset for speeds, feeds and indexing of the main turret head and side head.

The length of vertical travel of the five-tool turret main slide and its cross traverse are preselected and determined by the setting of stops in grooved slides. These stops have coarse and fine position setting and the movements of the four-tool side head turret are controlled by similar stops. Each saddle is fitted with a multiple limit switch in which there are two contacts for each tool station. These contacts are actuated by the stops and one controls the movement of the tool into the work and the other its movement away from the work. Indexing of the tool turrets takes place automatically on the outermost slide position from the work and the turrets are hydraulically locked after indexing. By the removal of appropriate stops multiple indexing can be effected to pass through any of the non-tooled stations on a turret.

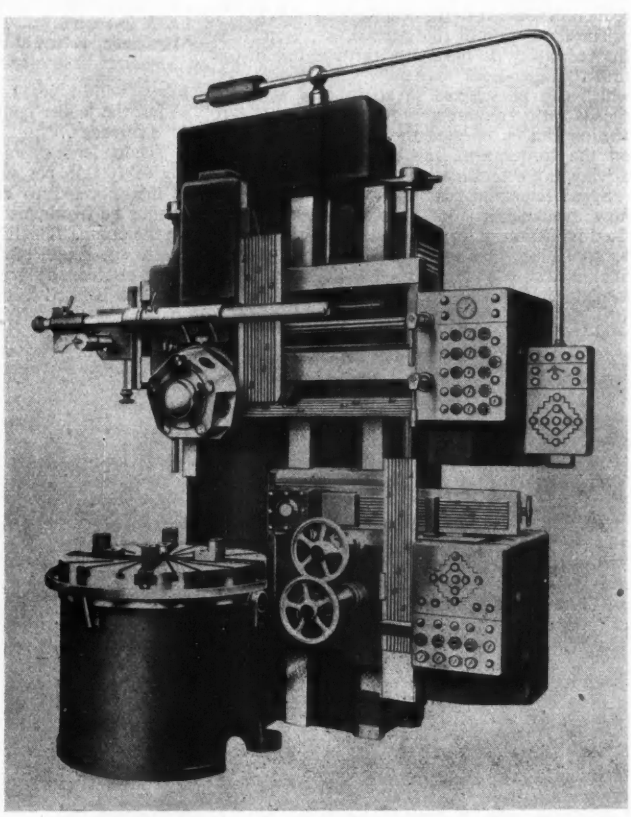
Feed and speed rates and the indexing movements of the turrets are preselected by knobs on the panels to be seen on the right-hand side of the machine. At the conclusion of each machining operation the following operation is automatically started at the required feed and speed rate until the machining cycle is completed, when the machine automatically stops. A signal lamp on the control panel shows the operation in progress, and the sequence of operations can be interrupted at any time and replaced by manual control.

The heads are each operated by rotating shafts which are driven by an individual hydraulic motor driving through a splined shaft and reduction gearing. A variable delivery pump feeding the hydraulic system is driven by a shaft from the table drive. The stepless range of feeds made available by this form of drive is from 0·002in to 0·2in per revolution of the table. Each motion has a rapid traverse speed of 120in per minute and the drive for this is supplied by a separate 3 h.p. motor.

The table is driven by a 40 h.p. motor and has thirty-two speeds from 6 to 300 r.p.m. It takes work weighing up to 3 tons and parts up to 43in high can be machined on it.

A semi-automatic screwing mechanism can be used for cutting English or metric threads or scrolls with both heads. The change gearbox for this work is driven through a single-tooth clutch synchronised with the table drive. At the end of a cut the tool is returned at rapid traverse speed, and it automatically picks up the thread when fed in for the subsequent cut by the operator, who then initiates the feed movement by depression of a button.

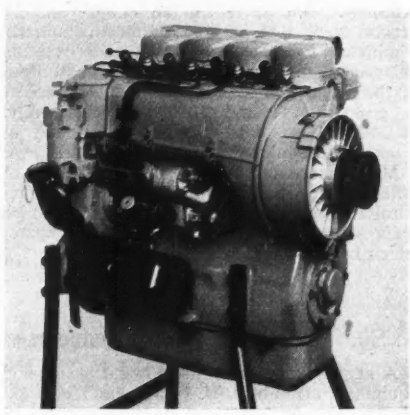
For taper turning purposes the horizontal and vertical feeds of a head can be coupled by a change wheel. If required, a profiling attachment can be fitted to the left hand of the cross rail, as shown in the illustration.



Vertical boring and turning mill with electro-hydraulic control mechanism for presetting feeds, speeds and turret head indexing

Air-Cooled Industrial Oil Engines

AMONG the engine exhibits at the recent Public Works Exhibition at Olympia, London, there were a number of air-cooled diesel engines made by Kloeckner-Humboldt-Deutz, of Cologne. Built for mobile or stationary industrial applications, engines of the " A/FL514 " and " A/FL614 " series are of 4⅜in bore and 5½in stroke, and are rated according to the number of



Four-cylinder, air-cooled industrial oil engine

cylinders employed to give from 8 to 250 b.h.p. at speeds from 1000 to 1800 r.p.m.

The " 514 " is a vertical in-line engine which is built in units having one, two, three, four or six cylinders. Our illustration shows a four cylinder motor of this class, which is cooled by means of a belt-driven fan blowing air through ducting over the cylinders. The same arrangement is used

for the " 614 " engines, which have six, eight or twelve cylinders grouped in vee form. In both cases the drive may be taken off at either end and speed control is by governor in the usual manner. The firm gives the fuel consumption of the single cylinder engine as 0·43 lb, and of the twelve cylinder unit as 0·40 lb/b.h.p./hour.

From these designs was evolved the " FL612 " range of one, two and four cylinder engines of 3½in bore by 4⅛in stroke, of which the four cylinder unit is rated at 56 b.h.p. at 2800 r.p.m. The cooling of these engines is done in a different manner by a flywheel blower.

Power can be taken off at either end of the crankshaft or at the camshaft at half the engine speed. An electric starter is fitted and there is provision for alternative hand-cranking at the camshaft. Vibration in the single cylinder version is stated to have been almost completely eliminated by the use of a counter-rotating balance weight on the crankshaft. The output of the single cylinder and two cylinder models is given as 11 and 22 b.h.p., respectively, at 2100 r.p.m., with a fuel consumption of 0·40 lb/b.h.p./hour at 1800 r.p.m.

Maintenance of a large park of engines of different sizes is assisted by the extensive standardisation which has been carried out, which reduces to the minimum the number of spares which have to be carried.

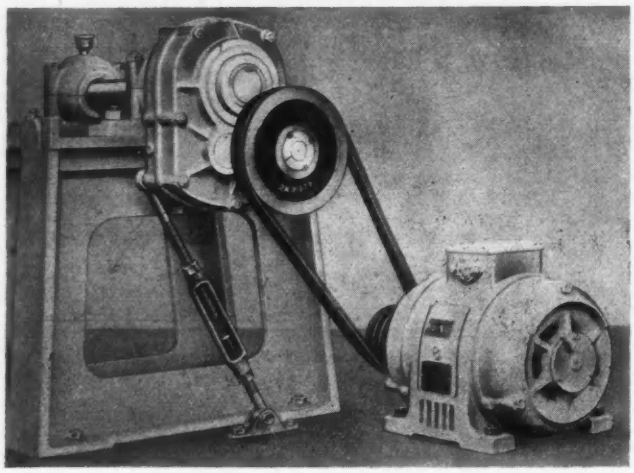
Shaft Mounted Speed Reducer

A RECENT addition to the power transmission equipment made by J. H. Fenner and Co., Ltd., Hull, is the shaft-mounted speed-reduction unit illustrated on this page. The new " Torque Arm " speed reducer, as it is known, eliminates need for lining up shafts, driving motor, &c., in an installation and dispenses with the use of bed-plates and couplings.

In the equipment a reduction gearbox, driven through vee belts, is mounted directly on the shaft to be driven. This shaft is locked into the bore of the gearbox by a collar at each end, and by using an adaptor bush if the shaft diameter is appreciably larger than the bore. A torque arm, fitted with a turnbuckle, anchors the reduction gearbox to the nearest fixed object.

The input side of the gearbox is driven from the vee pulley on the motor through one of the firm's " Taper-Lock " vee pulleys, the diameter of which can be selected in accordance with the speed ratio required. Adjustment of belt tension can be effected through the turnbuckle on the torque arm, and eliminates setting the driving motor on slide rails.

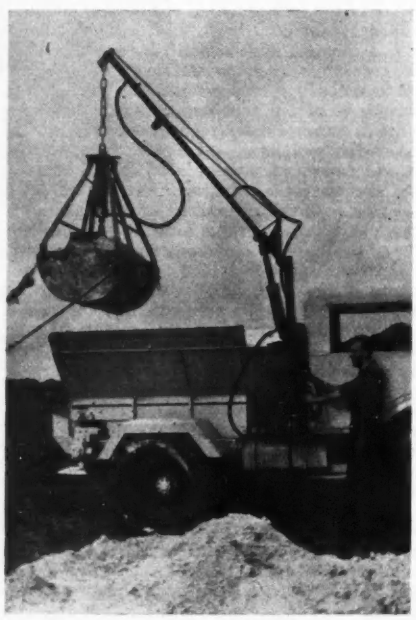
Speed reduction gear units of this design are now available in four standard sizes, with a fixed reduction of 15 to 1 and for power ratings up to 12 h.p. By selecting suitable vee pulleys final fixed speeds of between 9 and 134 r.p.m. are available. If it is at any time required to change the speed ratio of the drive the " Taper Lock " pulley on the reduction unit can quickly and easily be changed and the belt tension readjusted by the turnbuckle.



" Torque-arm " shaft mounted speed reducer with vee belt drive and " Taper-Lock " pulleys

Hydraulic Loader

A HYDRAULIC loader which can be mounted in position behind the driver's cab on most makes of commercial vehicles has been introduced by Stanhay, Ltd., Elwick Works, Ashford, Kent. The loader is fitted with a hydraulic grab which is suitable for handling loose commodities such as sand, gravel, ballast, small coal, bulk grain, bulk cement, and lime. A tined grab is also available for farmyard manure and the loader can be used without the grab, but with suitable slings for barrels, cases or bulky loads within its capacity. Our illustration shows the loader complete with grab fitted to a lime spreader.



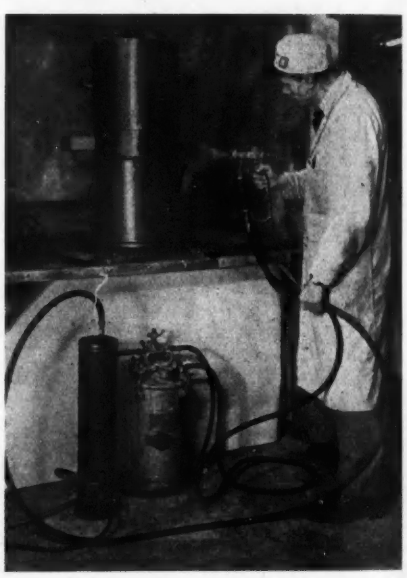
Hydraulic loader with ram-operated grab of 5 cubic feet capacity

The loader is operated by a gear pump operating at 1000 lb per square inch. A relief valve is incorporated to ensure that the equipment cannot be overloaded or undue strain imposed on the pump. The lifting capacity varies according to the length of the jib fitted, but loads up to 10 cwt can be handled. In the illustration the grab is fitted to the jib at 7ft 4in radius and will operate from ground level and discharge at a height of over 8ft. The lift can be stopped at any required height and the grab dimensions are given as : cubic capacity (flush), 5½ cubic feet ; average load, approximately 5 cwt ; distance between jaws open, 38in ; depth, 15in.

The jib is slewed manually, and will operate through a half-circle clear of the side of the vehicle, and completely over the vehicle (270 deg.). The method when loading is to incline the vehicle slightly away from the commodity being loaded, so that the loaded grab swings by gravity towards the discharge point, thereby leaving a light empty grab to be pulled back manually and guided down for the next load. A complete cycle of operations, i.e. grab, lift, slew discharge and return for the next grab takes approximately twenty-five to thirty seconds, giving a loading capacity of 1 ton every two minutes. The vehicle can be loaded with no hand trimming, or unloaded with a minimum of hand trimming, from the corners. It is possible to load direct from a heap or from another vehicle, and the grab can be lowered gently. The grab is completely closed hydraulically by a ram, giving an effort of 3¼ tons, thus ensuring maximum loads each time.

Air and Paint Preheaters for Paint Spraying

IN the spraying of cellulose lacquers the temperature reduction caused by expansion of the compressed air may be sufficient for moisture to condense on the paint film. This leads to a fault called " blushing " or " blooming," which, however, can be avoided by heating the air and the paint. The Ecco division of the Atlas Diesel Company, Wembley, Middlesex, has introduced the " LE750 " air heater and the " FV30 " paint preheater for use with its spray guns. The air heater is a pressure container fitted with an insulated and explosion-proof 750W heater element. Air from the compressor enters at the bottom and leaves at the top, the outlet temperature being thermostatically controlled within the range 86 deg. to 190 deg. Fah. The air then passes through a standard 12ft length of hose to the " FV30 " paint preheater, which consists of a honeycomb air coil inside the paint container. The fluid hose from the paint or lacquer container is connected to the bottom of the preheater, while the top connects to the fluid inlet at the gun.



Air and paint preheating equipment. Hot air from the thermostatically controlled heater on the left passes through the paint preheater attached to gun

The accompanying illustration shows the equipment. The air outlet of the preheater is connected to the air inlet of the gun ; in order to allow heating air to pass while the gun is not being used, a bleeder valve is incorporated

Another frequent fault, which occurs chiefly in outdoor work in cold weather, is insufficient coverage due to excessive thinning, which in turn is made necessary by the high viscosity of the cold paint. This can again be obviated by heating, and tests are said to have shown that the equipment is adequate even under the most adverse conditions.

High-Voltage X-Ray Generators for Industrial Radiography

BY OUR AMERICAN EDITOR

As a result of research on super-voltage radiography conducted at the Massachusetts Institute of Technology during the last war, a 2MeV Van de Graaff X-ray generator was developed for the U.S. Navy. Both this unit and a 1MeV generator are now being manufactured by the High Voltage Engineering Corporation, of Cambridge, Massachusetts, and are finding increasing application in the radiographic examination of heavy castings, forgings and weldments.

One outstanding property of X-rays in the 1MeV to 20MeV range is their penetrating power. As the tube voltage, or electron energy, is increased, the absorption coefficient of the X-rays decreases rapidly to a minimum value, which for steel occurs at about 8MeV. The useful radiation from a 2MeV X-ray generator is in a cone of about 30 deg. total angle in the forward direction, and in a cylinder about 30 deg. wide at right angles to the tube axis, thus permitting circumferential radiography. At 20MeV, the useful radiation is almost completely concentrated in a narrow cone of only about 9 deg. total angle in the forward direction. It is evident, therefore, that the radiographic techniques employed with these two radiations must be vastly different to obtain equivalent results.

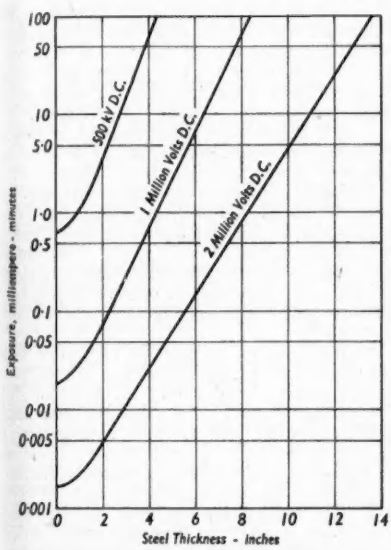


Fig. 1—Relationship between radiographic exposure and steel thickness

A recent cost analysis has shown that in the region of 2in to 12in steel thickness, cobalt-60 or 2MeV X-ray generators are more economical for production use than other radiation sources. It is interesting to note that, even for relatively thin sections which are in the range of 250kV equipment, the 1MeV to 2MeV units are less expensive per square foot of film. At thicknesses greater than 12in, the 20MeV source is more economical because of its great penetrating power, but the 20MeV unit has no advantage in the 2in to 12in range because of its narrow cone of useful radiation.

At 2MeV the small absorption coefficient of the radiation, coupled with the high X-ray intensity, allows radiographs to be made through steel sections much thicker than is possible with lower-voltage radiations. In practice, radiographs have been made with 2MeV generators through 14in of steel with reasonable exposure times. As an illustration of the short exposures required with a 2MeV radiation, the accompanying graph (Fig. 1) shows the trend of exposure with steel thickness for 0·5MeV, 1·0MeV and 2·0MeV X-rays from an electrostatic generator. The exposure values plotted all yield a net density of 1·0 on type "A" film when developed in Kodak rapid X-ray developer, 8 minutes at 60 deg. Fah., and relate to a 24in target-film distance.

The additional characteristics which must be combined with penetrating power and short exposure time are good radiographic sensitivity, a small X-ray focal spot, and an adequate X-ray field coverage. Throughout the super-voltage X-ray range, the radiographic sensitivities generally are comparable. The useful X-ray field size, however, decreases rapidly as the X-ray voltage is increased, necessitating larger radiographic distances to cover adequately the object being irradiated. The focal spot of conventional X-ray apparatus is normally too large to cast sharp shadows except in the case of thin objects or great radiographic distances. The Van de Graaff Model AR 2MeV X-ray generator was developed by the High Voltage Engineering Corporation to combine the important characteristics of penetration, speed, spot size, and field coverage. In the accompanying illustration (Fig. 2), the equipment can be seen operating in the radiographic examination of a welded pressure vessel shell. With this machine, a 14in by 17in radiographic film can be completely covered in one exposure at a target-film distance of 40in. Up to a practical steel thickness limit of 12in, discontinuities anywhere within a 30 deg. cone of radiation can be recorded with detail limited only by the orientation of the flaw and the characteristics of the film. It has been found that separations smaller than 0·001in can be detected and that thickness changes of 0·5 per cent of the total section can be recorded. The wide latitude range of the machine of over 2¼in permits the significant recording of discontinuities in one exposure in objects of irregular shape and thickness.

The forward-directed (or transmitted) X-ray beam of the unit is of greatest intensity and penetrating power. The sideward-directed (or reflected) beam is particularly useful, however, for the radiography of circumferential seams or for the exposure of several films mounted about the generator axis. In many applications the gain in total film area or length exposed with this arrangement more than offsets the slight loss in intensity and penetrating power. The focal-spot size and the resulting definition are maintained at the maximum quality, whether the transmitted or reflected beam is used. When the reflected beam is to be used, the target shield is removed so that the sideward-directed X-rays are unimpaired in their intensity. The diameter of the gold X-ray target is less than 3½in, making possible the circumferential radiography of smaller objects such as flanges, pipe welds and cored castings. The low scattering characteristic of 2MeV X-rays makes the normal radiographic procedure simple; blocking and screening techniques are not usually required. It has been found that the best exposure results are obtained using high-contrast film sandwiched between lead intensifying screens 0·005in to 0·010in thick, in either cardboard exposure holders or metal-frame cassettes. A lead sheet ⅛in to ¼in thick covering the film holder serves to screen out the residual soft X-rays scattered from the object or the room. In general, it is unnecessary to provide any heavy shield at the back of the film holder.

The following specifications apply to the 2MeV machine which is illustrated in Fig. 3 :—

Voltage	2MeV, constant-potential, electronically stabilised
Target current	0·01 to 0·25mA, d.c.
Radiation output	75 röntgens per minute at 100cm, measured in the forward direction
Inherent target filtration ...	9mm lead equivalent
Half-value layer	0·83in steel
Focal spot diameter	0·5mm

The Van de Graaff generator comprises a voltage generator which consists of a pressured steel housing and base plate containing power supplies, a belt-drive motor and pulleys, a voltage-generating column, a charging belt, a high-voltage terminal with the cathode and its controls, and a multiple-sectioned acceleration tube. Steel trunnions, which are mounted at the centre of gravity of the generator, provide a lifting and tilting means. The vacuum-pumping system of the generator consists of a high-speed mercury-diffusion pump, a cold trap, a mechanical fore-vacuum pump, a vacuum gauge, and protective circuits. The complete vacuum system is mounted at the generator base on a swivel joint so that the system remains vertical when the generator is tilted. The machine is usually provided with a remote control desk console which contains the necessary operating controls together with instruments to give continuous readings of generator voltage, target current, focusing-magnet current, exposure time and vacuum-system conditions. No other auxiliary apparatus is required for operating the X-ray generator.

The target shield, which conforms to the National Bureau of Standards Class III, reduces

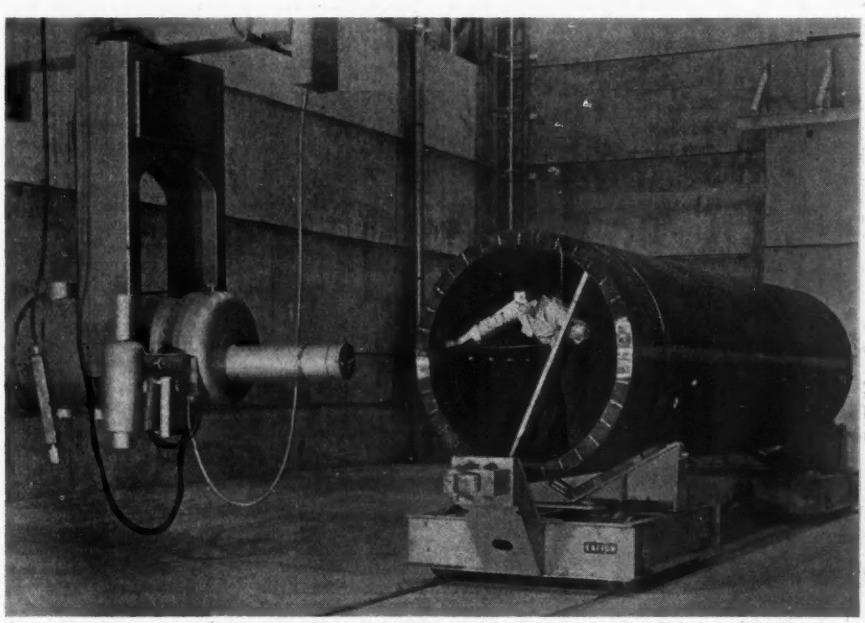


Fig. 2—Radiographic examination of welded pressure vessel shell

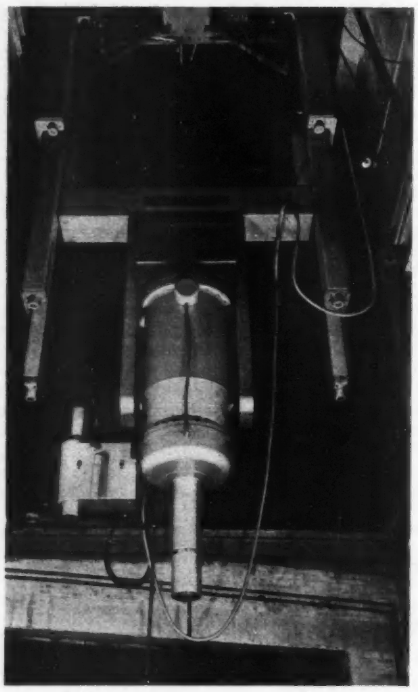


Fig. 3—2MeV Van de Graaff X-ray generator with telescopic mounting, suspended from overhead travelling crane

the X-ray intensity to less than 1 per cent of the forward-directed intensity, providing a radiation cone 45 deg. in total angle in the forward direction. The face of the target shield is fabricated to accept insert cones which may be used to restrict the radiation to smaller angles. A flanged extension supports this lead target shield from the generator base and houses the focusing magnet, the tube extension and the water cooled gold X-ray target.

The method of supporting the Van de Graaff X-ray generator depends on the individual requirements of the installation. The generator can be lifted and rotated about a horizontal axis provided by two trunnions welded at the centre of gravity of the equipment. In the standard mounting arrangements the X-ray unit is enclosed in a yoke which contains the motorised drives for tilting the unit and for rotating the yoke assembly in the horizontal plane. All movements are electrically powered and are controlled from a pendant push-button station near the generator. The maximum lifting range is obtained using a mount consisting of two sets of telescoping box members which attach to the thrust bearing of the yoke. The telescoping members are accurately guided on heavy-duty rods, with ball bushings acting as the bearing surfaces. A rigid sway-free mounting is thus ensured. This mount may be attached to overhead " I "-beams or to the trolley of a bridge crane.

At the recent annual meeting of the American Society for Testing Materials the High Voltage Engineering Corporation announced its Van de Graaff " JR " 1MeV X-ray generator which has been designed specifically as an economical, transportable source of super-voltage radiation. The unit, which is shown in Fig. 4, weighs about a ton. Steel thicknesses up to 4½in can be penetrated by the machine with an exposure time of 30 minutes, and it has a radiation output of 8 röntgens per minute at 100cm, measured in the forward direction. The focal spot of the generator is less than 1mm in size.

Fig. 4—Radiographic examination of casting with 1MeV Van de Graaff X-ray generator

Nuclear Science and Electronics Laboratories at M.I.T.

Dr. James R. Killian, Jr., president of the Massachusetts Institute of Technology, speaking at a convocation in commemoration of the late Dr. K. T. Compton, recently announced plans for building the Karl Taylor Compton laboratories for nuclear science and electronics at the Institute in Cambridge, Massachusetts. The M.I.T. nuclear reactor, which is to be devoted solely to education and non-secret research in the peace-time applications of nuclear power, will also be associated with these laboratories. The proposed laboratory building to honour Dr. Compton will comprise about 125,000 square feet of floor area and will be designed especially for M.I.T.'s work in nuclear science, nuclear engineering, electronics, and related activities in the departments of physics, electrical engineering and chemical engineering. It is well known that Dr. Karl Compton developed the Massachusetts Institute of Technology into one of the leading—if not the leading—scientific institutions in America. Soon after Dr. Compton came to M.I.T. as president in 1930, he set about building a flourishing school of science with a greatly expanded post-graduate programme. As a result, during the twelve-year period from 1936 to 1948, M.I.T. awarded more doctor's degrees in physics and in engineering than any other university in the United States—nearly 10 per cent of all physics degrees and more than 15 per cent of all engineering degrees. In the same period nearly 5 per cent of the country's doctor's degrees in chemistry came from M.I.T.

The research laboratory of electronics, which will share the new facilities of the Karl Taylor Compton Laboratories, was founded at M.I.T. just after the last war ; it now has 245 staff members and a total research and teaching budget of about 1,500,000 dollars yearly. The work of the research Laboratory of electronics has included such developments as a language structure project involving both the humanities and the physical sciences. A group of language specialists has been working with physicists and engineers in this laboratory in an effort to gain better understanding of the structure of language and to use this understanding to develop machines for translating one language into another. Other examples may be found in the research work going on for diagnosing by electronic means various diseases and in the development of new concepts for aiding the blind, the deaf, and the dumb to have communication with the world around them. Recently, one of the members of this laboratory, who is himself blind, worked out a design which promises to provide a radar-like instrument which a blind person could carry in a briefcase and which would look ahead for him.

The existing laboratory for nuclear science at M.I.T. operates a group of high-energy particle accelerators not equalled at any other educational institution in the Eastern United States. In addition to research on the design and construction of such machines, the laboratory is undertaking fundamental studies of nuclear theory, cosmic rays, nuclear chemistry, and other problems associated with nuclear structures and forces and the fission process and its products. This work in the laboratory for nuclear science is to-day being carried on by about 160 faculty members with an annual budget of about 1,000,000 dollars for research and teaching.

Tunnel-bridge Scheme Across the Hampton Roads in Virginia

The Virginia State Highway Department has announced the award to the Merritt-Chapman and Scott Corporation of New York of a contract for a 4 miles long tunnel-bridge scheme which will provide the first direct vehicular route across the Hampton Roads in Virginia. A " trench " tunnel and two low-level approach bridges of reinforced concrete, linking Willoughby Spit, near Norfolk, on the south shore with a point near Hampton on the north shore, are the major works of the project which has been described by the Virginia State Highway Department as the largest in its history. The tunnel and bridges were designed by Parsons, Brinckorhoff, Hall and Macdonald, of New York, who will serve as consulting engineers during construction.

The trench tunnel will consist of a large steel tube casing prefabricated ashore in twenty-three sections which will be filled with an inner ring of concrete, floated into position, and then sunk and locked into place in a deep trench dredged across the river bottom. Concrete will then be placed under water around the tube and, finally, the tunnel will be covered with sand. The underwater section of the Hampton Roads tunnel will be approximately 6860ft long and each one of its twenty-three sections will have a deadweight of about 12,000 tons. At each end of the underwater tube, man-made islands rising to an elevation of 11ft above mean sea level will be built up by fill methods to connect the tunnel with the concrete approach bridge. The tunnel will have a 23ft wide, two-lane roadway and will be 113ft below the surface at the deepest point. The approach bridges will be 30ft wide, also providing for two lanes of traffic. The bridge leading from Willoughby Spit to the South Island will be about 6110ft long. The other one, leading from the Hampton shore to the North Island, will be about 3250ft in length.

Of the ten trench tunnels constructed to date in the United States, the Merritt-Chapman and Scott Corporation has built four—the vehicular Washburn Tunnel beneath the Houston Ship Channel at Pasadena, Texas ; the State Street double subway crossing beneath the Chicago River at Chicago ; the underwater section of the vehicular Detroit-Windsor Tunnel beneath the Detroit River, and the vehicular tunnel beneath the Southern branch of the Elizabeth River between Norfolk and Portsmouth, Virginia.

Extruded Automobile Engine Pistons.—Trials are being carried out with extruded aluminium alloy pistons for motor-car engines, made by the Light Metals Division of Thompson Products Inc, Cleveland, Ohio. These pistons are made by an impact extrusion process and are claimed to be twice as strong as and 30 per cent lighter than the other pistons made by the firm. In the process of manufacture a heated slug of material is formed in heated dies in a press. After the flash has been removed the piston is heat-treated and then finish machined in the usual way.

Industrial and Labour Notes

Iron and Steel Production

The production statistics for November, which were issued on Wednesday by the Iron and Steel Board, indicate that this year's output of steel ingots and castings will quite likely exceed the estimate of 18,500,000 tons. Steel production in November averaged 377,000 tons a week and was therefore at an annual rate of output of 19,606,000 tons, which, once more, is the highest recorded in any month. In November last year steel was produced at an annual rate of 18,878,000 tons. Pig iron output last month averaged 235,000 tons a week, which represented an annual output rate of 12,236,000 tons, compared with an annual rate of 11,883,000 tons in November last year.

Iron and Steel Prices

At the end of last week, the Iron and Steel Board announced changes in the maximum basis prices of most descriptions of iron and steel. These changes became effective on December 6th.

Among the changes are increases of 5s. a ton in the price of basic iron and 12s. 6d. a ton of foundry pig iron in most zones, with higher increases in the remaining zones. Prices of cylinder and refined malleable pig iron have been removed from control. Prices of the basis qualities and sizes of many of the more important steel products are not altered. These include plates, heavy sections, tubes and tinplate. The basis prices of other products have been changed, there being, for example, increases of 22s. 6d. a ton in the price of boiler plates, 10s. a ton in the price of heavy rails, 32s. 6d. a ton in the price of uncoated hand mill sheets, and 31s. 6d. a ton in the price of galvanised sheets. On the other hand, soft basic bars and hoop and strip have been reduced by 7s. 6d. a ton and hard bright cold rolled strip by 25s. a ton. A new factor in the price changes is the introduction of zone extras for billets, which reflects in a broad way the additional cost of delivery to areas distant from the main steel producing centres. Another point about the price changes is that increases have been made in the extras permitted for special qualities and sizes of many products as these, it is stated, were too low in relation to the extra cost involved, as compared with standard products.

In announcing the changes, the Iron and Steel Board says that they represent the final step in the general review of the level and structure of prices which the Board has made this year. Interim price adjustments were made last March for pig iron and in May for some other products. These earlier changes, together with those now effected, have resulted in an increase of about 3 per cent in iron and steel prices. The Board explains that it has followed the general principle of determining maximum prices by reference to cost of production and margins for depreciation and profit. It is pointed out that there have been substantial increases in the capital employed per ton of product and in the level of capital costs since margins were last determined early in 1949. Margins have consequently been adjusted to take account of these factors. It is also explained that there have been significant increases in production cost this year, notably so far as coal, coke and transport are concerned. On the other hand, the Board says, there have been substantial savings resulting from a fall in the price of imported raw materials, from a reduction in the quantity of imported steel and from increased efficiency in the operation of modern plant.

Iron and Steel Scrap Order

The Minister of Supply, following consultation with the Iron and Steel Board, has made an order which consolidates the Iron and Steel Scrap (Nos. 1-4) Orders. This new order, entitled the Iron and Steel Scrap Order, 1954, came into force on December 6th ; it provides for the removal of price control from wrought iron scrap and restricts price control of all other iron and steel scrap sold to or bought by consumers.

Under the terms of the order, the maximum prices of the better classes of iron and steel scrap have been increased by amounts varying from 2s. 6d. to 30s. a ton. These increases, it is stated, are designed to secure the proper sorting and preparation of scrap by producers and merchants by providing more adequately for the cost of these operations. The Ministry of Supply says that the British Iron and Steel Federation and the National Federation of Scrap Iron, Steel and Metal Merchants have given assurances that their members will do their best to ensure that the objects of the new order are achieved.

Raw Materials for Ironfoundries

The Council of Ironfoundry Associations says that the increases in the prices of pig iron and scrap have come " as a severe blow to ironfounders, particularly those dependent directly or indirectly on export markets." The Council has also expressed disappointment at the increase of 3s. a ton in the price of foundry coke.

In a statement setting out these expressions of opinion, the Council acknowledges that some increase in pig iron prices had been expected for a long time. Moreover, it agrees that, taking everything into consideration, the increase is moderate in amount. The statement says that the Council has registered its opposition to any general increase in scrap prices. It comments that the increase in the price of the better grades of steel scrap is intended to encourage more careful selection and preparation, and adds that " this has meant a corresponding increase in the price of steel scrap to ironfounders."

Railway Wages

Last week, the executive of the National Union of Railwaymen decided that an approach should be made to the British Transport Commission for a further wage increase. The amount in the union's mind is one that would bring wages to a full 15 per cent above the December, 1953, level. It will be recalled that, at the beginning of October, after nine months of negotiations, agreement was reached by the three railway unions and the British Transport Commission on a basis for a new wages structure. Revised schedules of rates of pay resulting from that agreement operated from October 4th and wage increases ranging from 6d. to 6s. 6d. a week, according to length and grade of service, were made.

On Monday, Sir Brian Robertson, chairman, and other members of the British Transport Commission met representatives of the National Union of Railwaymen. Afterwards it was stated that Sir Brian pointed out that the agreement reached in October must be considered as a settlement in the negotiations which began with the wage demand of last December. But, it was added, if the union felt that there was ground for further increases, it should formulate a new claim. That suggestion does not appear to have been satisfactory to the N.U.R. executive, which decided on Tuesday to approach the Minister of Transport in order to direct his attention to the " dangerous situation " that exists on the railways. It has been stated that the N.U.R. also proposes to urge the Minister that " some of the £124,000,000 profit which the Government made from its rental of the railways during the years 1940 to 1947 " should be restored to the railways. As these notes go to press it is announced that the meeting between the Minister of Transport and representatives of the N.U.R. is to be held next Monday.

Budget Policy

The Engineering Industries Association has published the text of a statement which it has submitted to the Chancellor of the Exchequer, setting out suggestions for consideration in framing next year's Budget. The statement says that the representations are being put forward at a time when there is a considerable degree of national prosperity, full employment and high productivity. But, it continues, the percentage of world trade which is being secured by Britain's exports must be augmented by further increases both in the volume and efficiency of our production.

The Engineering Industries Association expresses the view that long-term budgetary policy must be framed to assist the stabilisation of the nation's economy through increased export production and the establishment of a standard of living related to sound money values. It considers the present high level of taxation as one of the greatest contributions towards inflation because of its effects on internal price levels and wage demands. High taxation, the statement comments, acts as a deterrent to further effort and restricts the amount of capital available for investment. The statement goes on to say that reductions in the taxation of industrial profits, the taxation of personal incomes, and indirect taxation should result in the maintenance of competitive prices for export, more funds becoming available for capital investment, stabilisation of the cost of living, and reductions in demands for increased wage rates unless justified by increased production.

The Association's statement then says that if future budgetary policy could be framed to include a programme of progressive taxation reliefs, British industry would be prepared to shoulder the consequent responsibilities. Industrial policy must be expansionist and its aim must be reduced prices and increased sales. Healthy profit levels, the Engineering Industries Association asserts, which are an integral factor of an expansionist policy and of full employment, must be obtained through increased turnover and not through increased prices. At the end of its statement the Association says it realises that it is not possible, without creating excessive internal purchasing power, to introduce at one time all those measures of taxation relief which would give the greatest stimulation to industry. At the same time, it claims that a definite programme of taxation reliefs and incentives would intensify the drive for further production. The Engineering Industries Association considers, therefore, that the time has arrived when a long-term but definite programme of taxation reliefs and incentives should be considered and publicly acknowledged by the Government.

Employment and Unemployment

In its latest report on the employment situation in Great Britain, the Ministry of Labour states that, at the end of October, the total working population numbered 23,721,000. Of that total, 22,632,000 (15,011,000 men and 7,621,000 women) were in civil employment, which was 18,000 more than at the end of September.

A more detailed analysis of civil employment in October shows that 3,976,000 people were at work in the basic industries of the country. This was 41,000 less than in September, the decline being a seasonal one in agriculture and transport. In the manufacturing industries there was an addition of 54,000 to the labour forces, the total by the end of October being 9,192,000. In " engineering, metal goods and precision instruments " there was an addition of 18,000 to the labour force, bringing the total to 2,698,000, compared with 2,594,000 a year earlier. In the vehicle building industry there were 1,197,000 employed at the end of October, which was 7000 above the total at the end of September.

The latest unemployment figures show the position on November 15th, when 263,059 people were registered as out of work, compared with 253,914 on October 11th. The November figure includes 10,666 who were described as " temporarily stopped," and the Ministry of Labour says that the total represented 1·2 per cent of the working population. The Ministry says also that, taking the November 15th unemployment figure, the number who had been out of work for more than eight weeks was 100,000, which was about 40 per cent of the wholly unemployed.

Notes and Memoranda

Rail and Road

L.M.R. Training School at Derby.—The London Midland Region of British Railways is now converting railway buildings in Litchurch Lane, Derby, into a fully equipped training school for apprentices in the carriage and wagon works. Part of this building has been in use for some time for apprentice training, but only for certain trades. When the present work is completed facilities will be provided for the training of ninety apprentices in all trades in the Derby carriage and wagon works.

Air and Water

Lloyd's Wreck Returns.—Lloyd's Register of Shipping has issued its returns of merchant ships totally lost, broken up, &c., during the quarter ended March 31, 1954. The world total of steamships and motorships lost consequent upon casualty amounted to 45 ships of 76,119 tons gross, of which 10 ships of 32,021 tons belonged to Great Britain and Northern Ireland, and 9 ships of 3593 tons to the other Commonwealth countries. The corresponding figures for ships lost not consequent upon casualty are, respectively, 103 ships of 333,476 tons gross, 38 ships of 144,105 tons, and 5 ships of 11,457 tons.

Conference on Problems of Aircraft Production.—The Southern Section of the Institution of Production Engineers is organising a third annual conference on "Problems of Aircraft Production." It is to be held in the University of Southampton on January 14 and 15, 1955. The object of the conference is to bring together senior executives responsible for the design and production of aircraft, for the purpose of discussing and arriving at a mutual understanding of each other's problems. The theme of this forthcoming conference is "Integral Construction Contrasted with Traditional Methods." Full details of the programme and forms of application for conference tickets may be obtained from the Secretary of the Institution of Production Engineers, 10, Chesterfield Street, London, W.1. The conference fee, which includes the official luncheon on Friday, January 14th, and other refreshments, is 30s. for members of the Institution and affiliated representatives, and 35s. for non-members. Tickets will be allotted in order of date of receipt of applications, the closing date for which is Wednesday, January 5, 1955.

Miscellanea

Sir William Larke Medal.—The council of the Institute of Welding has awarded the Sir William J. Larke Medal for 1954 to Dr. C. L. M. Cottrell for his paper "Hydrogen—Barrier to Welding Progress?" Dr. Cottrell, who was until recently a member of the staff of the British Welding Research Association, is now on the research staff of the English Electric Company, Ltd., at Rugby.

Light Alloy Sledges.—Sledges built in the form of a punt and fabricated from aluminium, supplied by James Booth and Co., Ltd., have been tested by the British (Sherborne-Cambridge) Spitzbergen Expedition, 1954. Three sledges were constructed, one 12ft long and two 8ft long, having the main shell formed from a single sheet of 16 S.W.G. M.G.5 alloy with welded edge stiffeners of M.G.5 plate. Each sledge is 2ft 8in wide by 8in deep and has runners of extruded top hat section.

Tube Cutting and Screwing Machine.—In our issue of February 23, 1951, we gave details of a portable tube cutting and thread milling machine distributed in this country by J. C. Neville, Ltd., 34, Priests Bridge, London, S.W.14. A new model of this machine now available handles tubes from ¼in to 4in diameter, and is made for bench mounting as well as in portable form. A coolant pump is now fitted to the machine and cutters can be supplied to saw off and bevel tubes for welding in one operation.

Refuelling Pump.—A new pump able to deliver ready-mixed petrol and lubricating oil for refuelling two-stroke motor cycles has been developed by Avery-Hardoll, Ltd., to the requirements of Shell-Mex and B.P., Ltd. Known as the "Petroiler," the new pump, which will be put into production next year, is a self-contained unit with tanks for petrol and two grades of oil, a meter and dispensing hose. The pump draws petrol and a selected grade of oil from the tanks, and mixes them thoroughly in the correct proportions.

Obituary.—We have learned with regret of the death, recently, of Mr. Harold Barker, manager of the Newcastle upon Tyne office of Babcock and Wilcox, Ltd. Mr. Barker, who was forty-nine, joined Babcock and Wilcox, Ltd., in 1921 and had had charge of the Newcastle office since 1950. He was a member of the Institute of Fuel. We also record with regret the death of Mr. G. S. Ramage, which occurred at Alloa, Scotland, on November 19th. Mr. Ramage had been secretary of the Harland Engineering Company, Ltd., since 1923 and financial director since June, 1953.

Modern Roads.—The British Road Federation, Ltd., 4a, Bloomsbury Square, London, W.C.1, has published a booklet entitled "Modern Roads for Britain—How to Get Them," in which it is pointed out that work on modernising the country's road system could be put in hand on imaginative lines without delay by means of road loans. It outlines a procedure for creating and administering such loans, shows that men, materials and machinery are available, summarises methods of highway finance used overseas and lists road building achievements in all parts of the world.

Corrosion Preventives.—A booklet entitled "Corrosion Preventives" has been published by C. C. Wakefield and Co., Ltd., 46, Grosvenor Street, London, W.1, and can be obtained free of charge upon application to the company. The introduction to the booklet discusses the general problem of corrosion and its cost, and then goes on to review the causes of corrosion, and the various forms and variations of attack. A table indicates the effect of climate on the corrosion rate of steel and a map illustrates the world distribution of corrosive influences. In the next section the nature of temporary corrosion preventives are reviewed with notes upon their composition, classification and testing, together with a table listing the properties and uses of the various types of preventive. The application and removal of corrosion preventives is dealt with, including remarks upon the cleaning and drying of the surface, and reference is made to typical applications. The booklet concludes with an abridged list of corrosion preventives and gives brief general data such as drying time, thickness of film, colour and the period of protection afforded for indoor and outdoor conditions.

Translucent Sheeting for Building.—Translucent sheeting made from glass-reinforced laminated plastics is now being manufactured by Saro Laminated Wood Products, Ltd., 45, Parliament Street, London, S.W.1. The sheeting is known as "Sarolite" or "Saropane," according to the form in which it is made; several sheet thicknesses are available, reinforced either with short lengths of glass fibre, random-laid, or with a woven glass fibre cloth. The sheets may be corrugated or plane, and they may be coloured. The plastic materials from which they are formed are polyester resins, which allow the manufacture of thermosetting laminates at low pressures. The makers state that the "Sarolite" and "Saropane" sheets have been subjected to extensive programmes of testing, in which strength, light transmission, and other properties have been investigated, and modified to suit applications in building. Weathering has been studied particularly, and an accelerated weathering machine was devised. The London County Council has stated that it is prepared to consider favourably the use of these sheets, subject to certain precautionary conditions, which were formulated following tests at the Fire Research Organisation.

Sand and Gravel Working in South-Eastern England.—Allocation of land for sand and gravel working to maintain output at a reasonable cost without causing serious damage to agriculture or to the landscape, in "Middle" and East Anglia and in Kent and East Sussex over the next fifty years, is the subject of a recent report of the Advisory Committee on Sand and Gravel, published by H.M. Stationery Office. In all three gravel regions the committee has estimated the average annual demand for sand and gravel over the next fifty years, but it is recommended that the Ministries of Works and Housing and Local Government should review these estimates regularly. The estimates total 5·7 million cubic yards a year: 2·0 from the "Middle" Anglia workings, 2·5 from those of East Anglia and 1·2 from those of Kent and East Sussex. The acreage needed to meet these demands over the next fifty years is put at a little under 17,000—8165 acres in "Middle" Anglia, 5680 in East Anglia, and 3030 in Kent and East Sussex. The committee, which was appointed in 1946 to make recommendations on future policy for the control under the Town and Country Planning Acts of the extraction of sand and gravel, has now published two general reports and twelve regional reports; reports to be published shortly concern East Lincolnshire, East Yorkshire, Wales and South-West England. The allocations are generally restricted to land of poor quality, with the result that in some areas the committee has been unable to indicate sufficient land for fifty years' working; it recommends, however, that the position should be reviewed in about twenty-five years to determine whether more agricultural land should be worked for gravel or whether supplies should be drawn from further afield. It also recommends that worked-out sites should be made as attractive as possible.

Personal and Business

Tiltman Langley, Ltd., is the new title of the company hitherto known as Tiltman Langley Laboratories, Ltd.

J. E. Baty and Co., Ltd., 39, Victoria Street, London, S.W.1, states that its telephone number is now Abbey 7382.

Mr. K. E. Woollatt and Mr. M. I. Prichard have been appointed directors of F. Perkins, Ltd., Peterborough.

W. G. James, Ltd., has changed its address to Kingsbury Works, Kingsbury Road, London, N.W.9 (telephone, Colindale 2381).

Niarchos (London), Ltd., states that Mr. Walter H. Saunders has become president of Transoceanic Marine Inc., its New York agents.

Brook Motors, Ltd., Huddersfield, states that its Nottingham sales office has been moved to 14, South Sherwood Street, Nottingham.

E. K. Cole, Ltd., states that Mr. A. J. Brunker, A.C.G.I., general export manager, has been appointed chief engineer of the company.

Mr. G. G. Roberts has joined Smiths Aircraft Instruments, Ltd., Cheltenham, as technical executive in charge of guided weapon activities.

The Rheostatic Company, Ltd., Slough, announces the retirement of Mr. L. Satchwell from the board of directors. Mr. Satchwell founded the business in 1921.

Venner, Ltd., states that Mr. F. E. London, representative in the North-Eastern Electricity Board area, is now resident at 10, Grosvenor Terrace, Bootham, York (telephone, York 3569).

Standard Telephones and Cables, Ltd., states that its rectifier division is being moved, on December 15th, from Boreham Wood to a new factory at Edinburgh Way, Harlow, Essex (telephone, Harlow 26811).

A. A. Jones and Shipman, Ltd., Narborough Road South, Leicester, has been appointed sole selling agent in Great Britain and various parts of the Empire for A.J.F. grinding and lapping machines manufactured in Switzerland.

The Sheffield Society of Engineers and Metallurgists states that the secretary, Mr. E. J. Thackeray is now conducting the Society's business from his home address at 32, Church Lane, Dore, Sheffield (telephone, Sheffield 73838).

Fina Petroleum Products, Ltd., 25, Victoria Street, London, S.W.1, states that Mr. H. W. Smith is transferring to head office as fuel oil manager. Mr. Guy Wiggins at present fuel oil manager, is succeeding Mr. Smith as south-east regional manager.

Mr. Henry F. Spencer has been appointed chairman of the British Institute of Management in succession to Sir Hugh Beaver. Mr. Spencer is the managing director of Richard Thomas and Baldwins, Ltd., and a director of the Steel Company of Wales, Ltd.

Mr. H. Foster-Smith, M.I.E.E., regional officer, production, inspection and test, British Electricity Authority, Birmingham, has been appointed by the United Nations to act in an advisory capacity on electrical plant to the Venezuelan Government.

The British Electricity Authority states that Mr. A. G. R. Bell, A.M.I.E.E., has been appointed generation engineer (operation), southern group, South-Western Division, in succession to Mr. P. L. Lutte, who has transferred to the northern group.

Dr. A. G. Touch has been appointed director of electronics research and development, Ministry of Supply, in succession to Air Commodore W. G. Pretty. Air Commodore C. A. Bell will succeed Dr. Touch as deputy director, electronics research and development (air).

The Mirrlees Watson Company, Ltd., announces the retirement of Mr. C. W. Kenyon, after fifty-one years in the company's service. For some years he has been manager of the stoker department at Stockport. Mr. Kenyon began his apprenticeship with the company in Glasgow in 1903.

Alfred Herbert (Australasia) Pty., Ltd., the associated company of Alfred Herbert, Ltd., of Coventry, has opened a new showrooms and offices on the corner of Booth and Taylor Streets, Annandale, Sydney. In addition to selling the tools and equipment of the parent company, the Australian firm acts as agents for some twenty-four other British firms and eleven American firms.

The Telegraph Construction and Maintenance Company, Ltd., has opened a new branch at Gloucester House, 270, Corporation Street, Birmingham (telephone, Birmingham Central 6191). Mr. J. H. Barham is in charge of the branch. The company has also opened new branches at Potters Buildings, Warser Gate, Nottingham (telephone, Nottingham 44559), in charge of Mr. J. L. Woollett, and at 16–17, Hills Terrace, Cardiff (telephone, Cardiff 27467), in charge of Mr. J. B. Livesey.

Launches and Trial Trips

Theseus, cargo liner; built by the Caledon Shipbuilding and Engineering Company, Ltd., for Alfred Holt and Co.; length overall 489ft, breadth moulded 64ft., depth moulded to upper deck 35ft. 3in., deadweight 9500 tons, sea speed 16 knots; seven cargo holds, fourteen 5-ton, four 7-ton, six 10-ton and one 50-ton derricks, electric deck machinery, three 350kW diesel-driven generators; one set of Metropolitan-Vickers three-cylinder, cross compound, high-pressure impulse turbines, 8000 s.h.p. at 112 r.p.m. of propeller, two Foster-Wheeler single-furnace boilers, one auxiliary boiler. Launch, November 10th.

Scottish Hawk, oil tanker; built by the Greenock Dockyard Company, Ltd., for the Scottish Tanker Company, Ltd.; length between perpendiculars 512ft, breadth moulded 69ft, depth moulded 38ft 6in, deadweight 16,400 tons on mean draught of 29ft 10in, service speed 14 knots; nine centre and eighteen wing cargo oil tanks, two cargo oil pump rooms, four 500 tons per hour cargo oil pumps, two 80 tons per hour stripping pumps, steam deck machinery; Wallsend-Doxford oil engine, six cylinders, 670mm diameter by 2320mm combined stroke, 6400 b.h.p., two cylindrical boilers, one 75kW steam-driven generator.—Launch, November 11th.

Bendigo, cargo liner; built by Alexander Stephen and Sons, Ltd., for the P. and O. Steam Navigation Company; length between perpendiculars 490ft, breadth moulded 69ft, depth to shelter deck 43ft, draught deep load 29ft 8¼in., deadweight 12,870 tons, gross tonnage 8782, service speed 18 knots; eight watertight bulkheads, six holds, derricks to lift 5, 10 and 15 tons and one 80-ton derrick, electric deck machinery; one set of geared triple-expansion steam turbines, service power 11,000 s.h.p., maximum power 13,000 s.h.p., steam supplied at 500 lb per square inch and 850 deg. Fah. by two Foster Wheeler boilers. Trial, November 25th.

British Patent Specifications

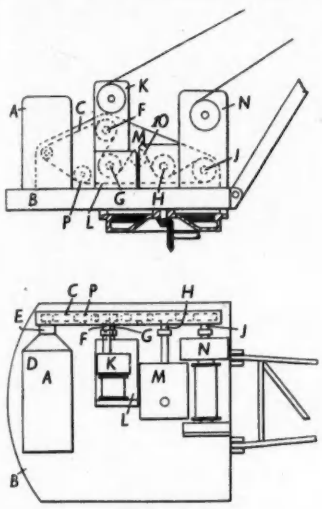
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

CRANES AND LIFTING DEVICES

717,312. February 14, 1951.—CRANES, K. and L. Steelfounders and Engineers, Ltd., Letchworth, and Clifford Symons Shaw, 80, Cowslip Hill, Letchworth.

The invention relates to cranes, hoists, derricks and the like, and has for its main object to provide an improved form of superstructure which can be readily assembled, operated and maintained. Referring to the drawing, the crane engine or motor *A* is mounted on a main platform *B* and is arranged to drive a primary transmission member *C* through a suitable clutch *D* and gearbox *E*, both of which



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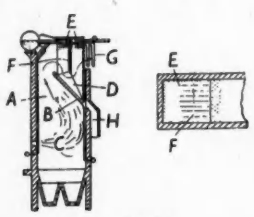
preferably comprise independent self-contained units. The primary transmission member *C* is in the form of a chain and constitutes a self-contained assembly from which four driving shafts *F*, *G*, *H* and *J* project preferably in parallel relationship for driving a set of units *K*, *L*, *M* and *N* controlling the hoisting, slewing, travelling and derricking movements. Two jockey or idler wheels *O* and *P* are interposed in the drive either to give an adequate wrap of chain or to give the necessary direction of rotation. Each of the controlling units are self-contained and each is provided with its own reversing clutches, gearbox and brake.—*October* 27, 1954.

STEAM GENERATORS

717,833. April 25, 1951.—FORCED CIRCULATION STEAM GENERATORS, Heinrich Vorkauf, trading as La Mont Kessel Herpen and Co., Kommanditgesellschaft, Geibelstrasse 14, Hanover, Germany.

The invention relates to the construction of combustion chambers of forced circulation steam generators, the object being to provide a construction which will permit of obtaining a high thermal rating combined with complete combustion of the gases. The drawing shows the combustion chamber *A* of a forced circulation boiler fired with pulverised fuel, gas or oil, and all walls of which may be lined with steam generating tubes. A gas-tight baffle wall *B* of steam tubes projects into the combustion chamber. This



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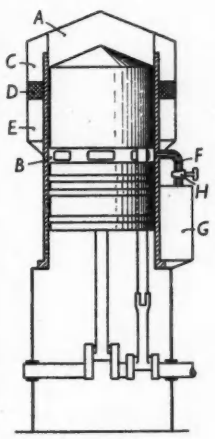
baffle divides the combustion chamber into a lower space *C* and an upper space *D* in which U-shaped tube panels *E* formed by steam generating or superheating tubes are placed behind the baffle wall. A deflecting baffle *F* is also provided in space *D*. By use of the baffle wall *B*, which in this case rises from the rear towards the front, the actions in the two spaces are prevented from influencing each other. While the steam generating tubes lining the walls of the combustion chamber *C* receive radiation on one side only, space *D* contains a generous amount of surfaces in the shape of the tube panels hung into the gas stream which are heated on both sides. The tube panels *E*, however, cannot influence the combustion temperature because of the baffle wall *B*. On the other hand, the gases passing through space *D* receive no radiation from the combustion space *C* and the gases are cooled as quickly as possible. By division into two spaces the function of each space is improved. On leaving space *D* the combustion gases pass across convection heating surfaces of which only the evaporator tube bank *G* is shown. The baffle *F* changes the direction of flow of the combustion gases in space *D* and particles in suspension are separated and can be removed through the duct *H*. Various types of boilers so arranged are shown in the specification.—*November* 3, 1954.

HOT-GAS ENGINES

717,663. July 22, 1949.—HOT-GAS ENGINES AND REFRIGERATORS OPERATING ON THE REVERSED HOT-GAS ENGINE PRINCIPLE, N. V. Philips' Gloeilampenfabrieken, Emmasingel 29, Eindhoven, Holland.

It is a known phenomenon that in hot-gas reciprocating engines and in refrigerators operating on the reversed hot-gas engine principle, working medium leaks away in time and results in a decrease in the power of the engine. The object of the invention is to provide for the working medium to be replenished in a simple manner. The drawing shows diagrammatically one arrangement of a hot-gas reciprocating engine according to the invention. The working space of the engine comprises a hot space *A* and a cold space *B*, which communicate with one another by way of a heater *C*, a regenerator *D*, and a cooler *E*. The cold space *B* communicates continuously by way of a tube *F* with an auxiliary chamber *G*. It is possible to vary the resistance to flow in the tube *F* in this embodiment of the invention by means of a cock *H*. During that part of the cycle in which the pressure in the working space is lower than the pressure in the auxiliary chamber *G*, a certain quantity of working medium will flow through the communication duct to the working space, whilst during that part of the cycle in which the pressure in the working space exceeds that in the auxiliary chamber, a certain quantity of working medium will flow through the communication duct to the auxiliary chamber. It is claimed that the power output of the engine under operating conditions is decreased by not more than 10 per cent and preferably by not more than 5 per cent, due to the arrangement described.—*November* 3, 1954.



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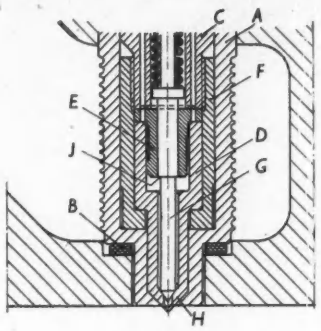
INTERNAL COMBUSTION ENGINES

717,685. July 10, 1951.—FUEL INJECTION DEVICE FOR HIGH-SPEED AIR-COOLED ENGINES, Schweizerische Lokomotiv-und Maschinenfabrik, Winterthur, Switzerland.

The invention concerns fuel injection devices for high-speed and air-cooled internal combustion engines wherein the nozzle is surrounded by a jacket which conducts heat away from the nozzle. The injector is cooled by the stream of combustion air entering the engine, located in the air intake port of the cylinder head. The internal parts of the injector are accommodated in a cooling jacket *A*, made of material of a high coefficient of heat-conductivity, which in turn is provided with cooling fins or ribs and is sealed at the bottom of the cylinder head by means of a heat-insulating packing seal *B*. The nozzle-holder *C* secured in the upper portion of the cylinder head carries at its lower end the nozzle body *D* with the needle guide sleeve *E* inserted between, and connected by the cap nut *F*. The fuel pressure controlled nozzle needle *G* loaded by the spring bears by its lower end against the inside of the nozzle head *H*. The fuel oil is supplied to the nozzle head through ports and filters and, when the injection pressure is reached, lifts the nozzle needle by the shoulder *J* against the pressure of the spring. The tip of the nozzle needle valve projects into a cylindrical bore with a hemispherically-shaped lower limiting surface. On the outside the nozzle head is of conical shape, its angle of conicity being about 90 deg. The fuel emerges from the nozzle in spray cones of wide angle. In order to render as favourable as possible the conditions of cooling of the nozzle head *H*, the conical seating of the cooling sleeve or jacket *A*



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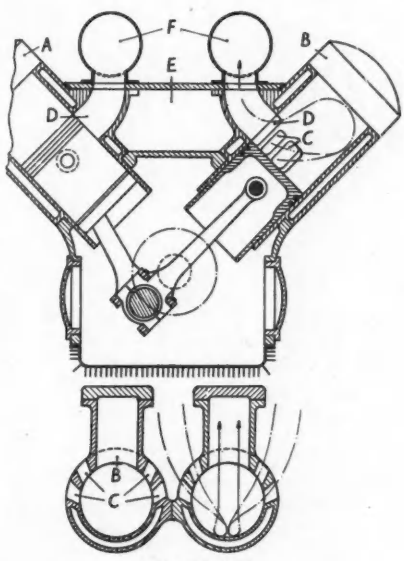
is extended into the immediate vicinity of the outlets of the nozzle holes. Such heat as does penetrate into the nozzle nose can be readily conducted away by the nozzle head wall, the thickness of which rapidly mounts with increase in distance from the nozzle holes, and be transferred, in the taper seating directly into the cooling jacket. Direct heat transmission from the cylinder head wall to the jacket is prevented by the packing-seal *B* and by an air space between the neck of the jacket and the cylinder head wall.—*November* 3, 1954.

718,012. May 19, 1950.—A TWO-STROKE "V" ENGINE, Klockner-Humboldt-Deutz, A.G., 22c, Koln, Germany. (*Inventor: Emil Flatz.*)

The invention relates to two-stroke internal combustion engines having rows of cylinders arranged in V formation, reverse loop scavenging and a scavenging air supply duct disposed in the space between the rows of cylinders. As shown in the drawing, the two rows of cylinders *A* and *B* of the engine are arranged in V formation. The individual cylinders show a reverse loop scavenging, as indicated by the arrows,



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the plane of symmetry of which extends transversely, preferably at 90 deg., relatively to the crankshaft. The scavenging ports *C* arranged symmetrically on both sides of the exhaust ports *D* lead directly to a scavenging air supply duct *E* arranged in the angular space between the rows of cylinders, whereas the exhaust ports on those longitudinal sides of the cylinder rows which face one another open into exhaust pipes *F* between the rows of cylinders at a distance from the crankshaft of the engine greater than that of the scavenging air supply duct. The angular space between the rows of cylinders is thus very well employed by the scavenging air supply duct and the exhaust pipes, so that these have no, or only little, bearing on the dimensions of the engine. The conditions are especially favourable when the angle enclosed by the cylinder rows is 90 deg. or thereabouts, because then the angular space enables the air duct and the exhaust pipes to be arranged without overcrowding.—*November* 10, 1954.

Contracts

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION, Ltd., Parnell House, Wilton Road, London, S.W.1, has received from Simon Carves, Ltd., a contract for the supply of two sets of coke-oven machines to be installed at the Burnpur Steelworks of the Indian Iron and Steel Company, Ltd.

ASHMORE, BENSON, PEASE AND CO., Stockton-on-Tees, has received a contract for two blast-furnaces from the Indian Iron and Steel Company, Ltd. The value of the contract is put at nearly £3,000,000. The furnaces are to be built at Burnpur, India, and will have hearths of 25ft diameter. They will each be capable of an output of 1200 tons of iron per day. The first furnace will go into production in 1958 and the second a year later.

THE GENERAL ELECTRIC COMPANY, Ltd., announces that its Fraser and Chalmers Engineering Works, Erith, Kent, has been awarded a contract for a turbo-blower to be installed at the Clyde Iron Works, Tolcross, Glasgow, of Colvilles, Ltd. The output of the machine is to be 75,000 cubic feet of dry air per minute at 60 deg. Fah., at a delivery pressure of 25 lb per square inch. The multi-stage, single-casing, high-pressure turbine will be supplied with steam at 270 lb per square inch gauge at a total temperature of 750 deg. Fah. and drive the four-stage centrifugal blower at 2750 r.p.m. The contract includes surface condensing plant and auxiliaries.

Catalogues

F. PERKINS, Ltd., Peterborough.—List No. 6214, "Display Aids for Retailers."

AITON AND CO., Ltd., Derby.—Brochure illustrating and describing girder clip assemblies.

B. ELLIOTT AND CO., Ltd., Victoria Works, Willesden, London, N.W.10.—Leaflet on "Excel" boring heads.

F. C. ROBINSON AND PARTNERS, Ltd., 287, Deansgate, Manchester, 3.—Booklet entitled "A Service to Industry."

CRANE PACKING, Ltd., Slough, Bucks.—Comprehensive catalogue of gland packings for general application.

COLVILLES, Ltd., Glasgow.—Booklet describing "Colclad" stainless clad, nickel clad, and monel clad steels.

BATES AND BATES, Ltd., 73, Ashville Avenue, Birmingham, 34.—Catalogue on electronic controls for resistance welders.

OWL ENGINEERING SUPPLIES Ltd., 16, South Parade, Doncaster, Yorkshire.—Folder dealing with vibrator conveyors.

VETRY, Ltd., Manor Way, Boreham Wood, Herts.—Leaflet illustrating and describing the Anderson autoflow ruling pen.

BOUND BROOK BEARINGS, Ltd., Trent Valley Trading Estate, Lichfield, Staffs.—Descriptive brochure on sintered brass parts.

FISHER AND LUDLOW, Ltd., Bordesley Works, Birmingham, 12.—Publication No. 504454, describing "Fisholow" flooring systems.

GENERAL ELECTRIC COMPANY, Ltd., Magnet House, Kingsway, London, W.C.2.—Illustrated booklet describing decorative lighting fittings for ships.

A. E. GRIFFITHS (SMETHWICK), Ltd., Booth Street, Handsworth, Birmingham, 21.—Publication entitled "Industrial Stoving Equipment."

ROCKE INTERNATIONAL, Ltd., 59, Union Street, London, S.E.1.—"Short Catalog" of electronic equipment manufactured by the Danish firm of Bruel and Kjaer.

PETTERS, Ltd., Causeway Works, Staines, Middlesex.—Booklet describing the complete range of petrol, diesel and TVO engines manufactured by the company.

ENGLISH STEEL CORPORATION, Ltd., P.O. Box No. 57, Sheffield, 9.—Brochure dealing with production of solid and hollow forgings up to 175 tons individual weight.

CONVEYANCER FORK TRUCKS, Ltd., Liverpool Road, Warrington.—Leaflet describing and illustrating "Conveyancer" fork trucks in the paper and printing trades.

THE STANDARD AND POCHIN BROTHERS, Ltd., Evington Valley Road, Leicester.—Publication No. 165A, illustrating and giving details of the "Lextra" roof ventilator.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., Imperial Chemical House, Millbank, London, S.W.1.—Booklet entitled "Corrugated Copper Jointing Strip for Expansion Joints."

MARCO CONVEYOR AND ENGINEERING CO., Ltd., Rowin Works, Leytonstone, London, E.11.—Boiler-house brochure illustrating all kinds of coal and ash-handling equipment.

SIEMENS ELECTRIC LAMPS AND SUPPLIES, Ltd., 38/39, Upper Thames Street, London, E.C.4.—New publications Battery Catalogue, PABX telephone exchange leaflet; time control equipment brochure and new bulkhead fitting leaflet.

MEASURING INSTRUMENTS (PULLIN), Ltd., Electrin Works, Winchester Street, Acton, London, W.3.—Latest edition of catalogue section "B," illustrating and describing the range of Pullin industrial switchboard instruments.

BUILDING PLANT EXHIBITION.—The Ministry of Works states that the 1955 Building Plant Exhibition will be held in Glasgow from June 8th to 15th next year. The site of the exhibition is on the Queenslie Industrial Estate, which adjoins the main Glasgow–Edinburgh road, some 3½ miles from the city centre. Adjoining the exhibition site there is an area of rough ground which is suitable for demonstrations of all kinds of plant.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

CHEMICAL SOCIETY

Thurs., Dec. 16*th.*—LONDON BRANCH: Burlington House, Piccadilly, London, W.1, "Some Newer Aspects of the Organic Chemistry of Nitrogen," G. R. Clemo, 7.30 p.m.

DIESEL ENGINE USERS ASSOCIATION

Thurs., Dec. 16*th.*—Caxton Hall, Westminster, London, S.W.1, Annual General Meeting, "Report on Heavy Oil Engine Working Costs and Performance, 1953," and an Informal Discussion on "Operating Problems," 2.30 p.m.

HULL CHEMICAL AND ENGINEERING SOCIETY

Tues., Dec. 14*th.*—Church Institute, Hull, "The Manufacture of Margarine and Cooking Fats," J. R. Scott, 7.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., Dec. 13*th.*—SHEFFIELD CENTRE: The University, Western Bank, Sheffield, 10, Presidential Address, E. C. Lennox, 6.30 p.m.——LEEDS CENTRE: E.L.M.A. Lighting Service Bureau, 24, Aire Street, Leeds, 1, "X-Ray Apparatus Medical Applications," F. L. Veale, 6.15 p.m.

Tues., Dec. 14*th.*—Lighting Service Bureau, 2, Savoy Hill, London, W.C.2, "Maintenance of Lighting Installations," J. Mortimer Hawkins, W. Robinson and J. W. Strange, 6 p.m.——LIVERPOOL CENTRE: Lower Hall, Liverpool College of Art, Hope Street, Liverpool, "Stage Lighting," P. Corry, 7 p.m.

Tues., Dec. 21*st.*—GLOUCESTER AND CHELTENHAM CENTRE: Cadena Cafe, High Street, Cheltenham, "Lighting of Parks and Gardens," H. A. Turner, 6.30 p.m.

INCORPORATED PLANT ENGINEERS

To-day, Dec. 10*th.*—W. AND E. YORKSHIRE BRANCH: Great Northern Hotel, Leeds, Film "Man with a Thousand Hands," 7.30 p.m.

Mon., Dec. 13*th.*—DUNDEE BRANCH: Mathers Hotel, Dundee, "Feedwater Treatment," E. L. Streatfield, 7.30 p.m.

Tues., Dec. 14*th.*—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "Fire Protection in Peace and War," K. N. Hoare, 7.15 p.m.——S. WALES BRANCH: Mackworth Hotel, Swansea, "Vacuum and Air in Industry," 7.15 p.m.

Wed., Dec. 15*th.*—GLASGOW BRANCH: Scottish Building Centre, 425/427, Sauchiehall Street, Glasgow, "Steam for Process," L. G. Northcroft, 7 p.m.——KENT BRANCH: Bull Hotel, Rochester, "Steam-Main Design and Modern Development in the Field of Gamma-Ray Examination of Pressure Welds," E. Marson and H. Webborn, 7 p.m.

Thurs., Dec. 16*th.*—BLACKBURN BRANCH: Golden Lion Hotel, Blackburn, "Lighting," Mr. Robinson. 7.30 p.m.——MERSEYSIDE AND N. WALES BRANCH: Radiant House, Bold Street, Liverpool, "Progress in Lamps and Lighting," R. V. Mills, 7.15 p.m.

Fri., Dec. 17*th.*—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, MOBILE PLANT DISCUSSION GROUP: Film, "Man With a Thousand Hands," 7.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Thurs., Dec. 16*th.*—LONDON BRANCH: Institute of Metals, 4, Grosvenor Gardens, London, S.W.1, "Melting and Casting under Reduced Pressure," H. H. Scholefield, 7 p.m.

INSTITUTE OF FUEL

Mon., Dec. 13*th.*—N.E. SECTION: Chemistry Lecture Theatre, King's College, Newcastle upon Tyne, "Experience with Spreader Stokers," T. H. Lindsay and P. Pilkington, 6.30 p.m.

Thurs., Dec. 16*th.*—MIDLAND SECTION: Imperial Hotel, Temple Street, Birmingham, "Social and Industrial Consequences of the Presence of Sulphur in Fuels," A. Parker, 6 p.m.

INSTITUTE OF INDUSTRIAL SUPERVISORS

Thurs., Dec. 16*th.*—LONDON S.E. SECTION: The Polytechnic, Woolwich, London, S.E.18. "The Production Supervisor and the Specialist," 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., Dec. 14*th.*—85, Minories, London, E.C.3, "Fuel Features Related to Operating Experiences in Motorships Using Low Cost Fuel," H. F. Jones, D. Royle and R. G. Sayer, 5.30 p.m.

INSTITUTE OF METALS

Mon., Dec. 13*th.*—SHEFFIELD LOCAL SECTION: The University, St. Georges Square, Sheffield, "The Park Gate 11 Continuous Bar Mill," W. Udall, 7.30 p.m.——SCOTTISH LOCAL SECTION: Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2, "Casting, Fabrication and Testing," 6.30 p.m.

Thurs., Dec. 16*th.*—LONDON LOCAL SECTION: 4, Grosvenor Gardens, London, S.W.1, "Melting and Casting under Reduced Pressure," H. H. Scholefield, 6.30 p.m.

INSTITUTE OF PHYSICS

Fri., Dec. 17*th.*—NON-DESTRUCTIVE TESTING GROUP: 47, Belgrave Square, London, S.W.1, "X-Ray Fluorescence Analysis," E. F. Priestley, 6.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., Dec. 13*th.*—N.W. CENTRE: Engineers' Club, Albert Square, Mancnester, "Tools and Equipment for Use in Workshops," 7.30 p.m.

Tues., Dec. 14*th.*—MIDLANDS CENTRE: Crown Inn, Broad Street, Birmingham, "Some Aspects of Vehicle Insurance and Accident Assessment," H. M. Gane, 7.30 p.m.

Thurs., Dec. 16*th.*—LONDON BRANCH: Royal Society of Arts, John Adam Street, London, W.C.2, "Automatic Chassis Lubrication," S. H. Edge, 6.30 p.m.——YORKSHIRE CENTRE: Hotel Metropole, King Street, Leeds, 1, "The 'Saro' Lightweight Body," C. E. Butterfield, 7.30 p.m.

Wed., Dec. 22*nd.*—N.W. CENTRE: Adelphi Hotel, Liverpool, "Maintenance," H. J. Jones, 7.30 p.m.

INSTITUTE OF WELDING

Tues., Dec. 14*th.*—N. LONDON BRANCH: Community Centre Lecture Room, Slough, "The Use of Oxygen in Industry," E. Ryalls, 7.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

To-day, Dec. 10*th.*—GRADUATES' AND STUDENTS' SECTION: Caxton Hall, Westminster, London, S.W.1, "The Training of the Chemical Engineer," F. Morton, 6.30 p.m.

Tues., Dec. 14*th.*—Geological Society, Burlington House, Piccadilly, London, W.1, "The Drying of Wheat Grain," Ewen McEwen and P. E. Gishler, 5.30 p.m.

Wed., Dec. 15*th.*—MIDLANDS CENTRE: The University, Edmund Street, Birmingham, "The Handling of Fire Powders," M. G. Bailey, 6.30 p.m.

Thurs., Dec. 16*th.*—N.W. BRANCH: The University, Leeds, "The Adiabatic Absorption of Hydrogen Chloride," T. A. Kantyka and H. R. Hinchlieff, 7 p.m.

INSTITUTION OF CIVIL ENGINEERS

To-day, Dec. 10*th.*—YORKSHIRE ASSOCIATION: Grand Hotel Sheffield, Symposium on "High Buildings," A. L. L. Baker 7 p.m.

Tues., Dec. 14*th.*—UNWIN LECTURE: Great George Street, Westminster, London, S.W.1, "Experimental Science and Civil Engineering Research," F. M. Lea, 5.30 p.m.

Wed., Dec. 15*th.*—N.W. ASSOCIATION: County Hall, Preston, "The Work of the Road Research Laboratory," Dr. Lonsdale, 5.45 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Dec. 13*th.*—RADIO SECTION: Savoy Place, London, W.C.2, Discussion on "Practical and Economic Problems in the Maintenance of Domestic Television Receivers," opened by W. L. Greenwood, 5.30 p.m.

Tues., Dec. 14*th.*—MEASUREMENTS SECTION: Savoy Place, London, W.C.2, "An Attracted-Disc Absolute Voltmeter," G. W. Bowdler, "The Use of an Electron Velocity Analyser to Stabilise a 50kV d.c. Voltage Source to a Few Parts in a Million," M. E. Haine and M. W. Jervis, "A Precision Direct-Current Stabiliser," M. W. Jervis, 5.30 p.m.

Wed., Dec. 15*th.*—SUPPLY SECTION: Savoy Place, London, W.C.2, "Short-Circuit Forces on Turbo-Alternator End Windings," J. B. Young and D. H. Tompsett, 5.30 p.m.——LONDON STUDENTS' SECTION: Public Library, Chelmsford, "Machines, Animals and Information," B. Z. de Ferranti, 7 p.m.——S.W. SCOTLAND SUB-CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Servo-Machines," W. S. Wood, 7 p.m.

INSTITUTION OF ENGINEERING INSPECTION

Mon., Dec. 13*th.*—WOLVERHAMPTON BRANCH: Compton Grange, Compton Road, Wolverhampton, "The Manufacture, Inspection and Testing of Springs," C. Harris, 7.30 p.m.

Tues., Dec. 14*th.*—S.W. BRANCH: Grand Hotel, Broad Street, Bristol, "Inspection in the Motor Industry," A. J. Peppiatt, 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

To-day, Dec. 10*th.*—Robert Gordon's Technical College, Aberdeen, "High-Pressure Boilers," T. Carlile, 7.45 p.m.

Tues., Dec. 14*th.*—39, Elmbank Crescent, Glasgow, "High Pressure Boilers," T. Carlile, 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Dec. 10*th.*—GENERAL MEETING: 1, Birdcage Walk, Westminster, London, S.W.1, "Cylindrical Pressure Vessels: Stress Systems in Plain Cylindrical Shells and in Plain and Pierced Drumheads," W. B. Carlson and J. D. McKean, 5.30 p.m.

Tues., Dec. 14*th.*—AUTOMOBILE DIVISION: GENERAL MEETING: 1, Birdcage Walk, Westminster, London, S.W.1, "Some Problems in Lubrication and the Substances Called Additives," A. Towle, 5.30 p.m.

Thurs., Dec. 16*th.*—INTERNAL COMBUSTION GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, "It Is Often Stated, Usually by 'Scientists,' that Industry Is Slow to Apply New Scientific Discoveries and Data, Both in Regard to Materials and Design. Is This True of the Internal Combustion Engine World?" 6.45 p.m.

Fri., Dec. 17*th.*—GENERAL MEETING: 1, Birdcage Walk, Westminster, London, S.W.1, Thomas Hawksley Lecture, "Recent Studies of Metallic Friction," F. P. Bowden, 5.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, Dec. 10*th.*—EASTERN COUNTIES BRANCH: Diocesan Hall, Tower Street, Ipswich, "Plastics: Materials, Processes and Machines," D. C. Nicholas, 7.30 p.m.

Mon., Dec. 13*th.*—SHEFFIELD SECTION: Grand Hotel, Sheffield, "Welding in the Atomic Energy Project," I. H. Hogg, 6.30 p.m.

Tues., Dec. 14*th.*—LONDON GRADUATE SECTION: 10, Chesterfield Street, London, W.1, "The Production and Application of Engineering Parts Prepared from Metal Powders," L. Harrison, 7.15 p.m.

Wed., Dec. 15*th.*—BIRMINGHAM SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, 3, "Shell Moulding," A. N. Wormleighton and G. Hannaford, 7 p.m.

Thurs., Dec. 16*th.*—GLASGOW SECTION: Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2, "Work Measurement," T. U. Matthew, 7.30 p.m.——LONDON SECTION: Royal Empire Society, Northumberland Avenue, London, W.C.2, "Budgetary Control at Shop Floor Level," F. T. Hunter, 7 p.m.——LINCOLN SECTION: Ruston Club, Unity Square, Lincoln, "Material Utilisation," F. Nixon, 7.30 p.m.——SOUTHERN SECTION: Polygon Hotel, Southampton, "Impact of U.S.A. Financed Companies on Productivity in Great Britain," J. H. Dunning, 7.15 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Wed., Dec. 15*th.*—YORKSHIRE BRANCH: Great Northern Hotel, Leeds, "Lackenby Steelworks," A. P. Clark and T. V. Thompson, 6.30 p.m.

Thurs., Dec. 16*th.*—11, Upper Belgrave Street, London, S.W.1, "Fabrication and Erection of Steel Plate Girder Railway Bridges," M. F. Palmer, 6 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Tues., Dec. 14*th.*—Royal Society of Tropical Medicine and Hygiene, 26, Portland Place, London, W.1, "Compounding of Vinyl Polymers," S. Mottram, 5.30 p.m.; "Polymer-modified Natural Rubber," F. M. Merrett and R. I. Wood, 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Dec. 10*th.*—INAUGURAL MEETING: Pepys House, 14, Rochester Row, London, S.W.1, Presidential Address, "Engineering in the Twentieth Century," S. J. Davies, 7.30 p.m.

Mon., Dec. 13*th.*—SHEFFIELD AND DISTRICT SECTION: Livesey Clegg House, Sheffield, "Post War Developments in Coal Face Machinery," S. McCallum, 7.30 p.m.

Fri., Dec. 17*th.*—INFORMAL MEETING: Pepys House, 14, Rochester Row, London, S.W.1, Question and Discussion Evening, 7 p.m.

LIVERPOOL METALLURGICAL SOCIETY

Thurs., Dec. 16*th.*—Liverpool Engineering Society, The Temple, Dale Street, Liverpool, "The Use of Protective Atmospheres during the Heat-Treatment of Steels," Ivor Jenkins, 7 p.m.

NEWCOMEN SOCIETY

Wed., Dec. 15*th.*—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, "History of Locomotive Power Transmissions," F. J. G. Haut, 5.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

To-day, Dec. 10*th.*—Literary and Philosophical Society's Lecture Theatre, Newcastle upon Tyne, "The Partnership of Science and Engineering," Sir Edward Appleton, 6.15 p.m.

OLD CENTRALIANS

Tues., Dec. 14*th.*—Chez Auguste Restaurant, 47, Frith Street, London, W.1, "The Place of the Electrical Engineer on British Railways," S. B. Warder, 12.45 p.m.

ROYAL AERONAUTICAL SOCIETY

Thurs., Dec. 16*th.*—TENTH BRITISH COMMONWEALTH AND EMPIRE LECTURE: Assembly Hall, Church House, Westminster, London, S.W.1, 6 p.m.

WOMEN'S ENGINEERING SOCIETY

To-day, Dec. 10*th.*—LONDON BRANCH: 35, Grosvenor Place London, S.W.1, Members' Evening, 6.30 p.m.